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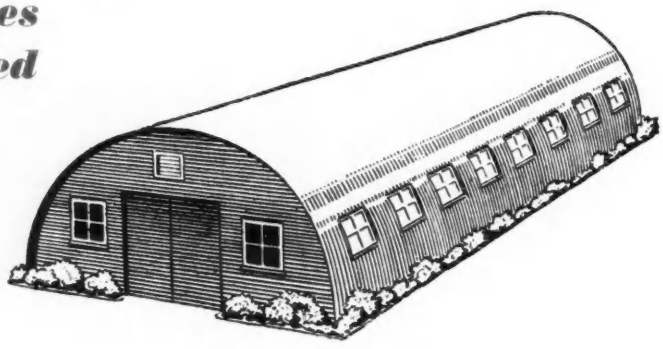

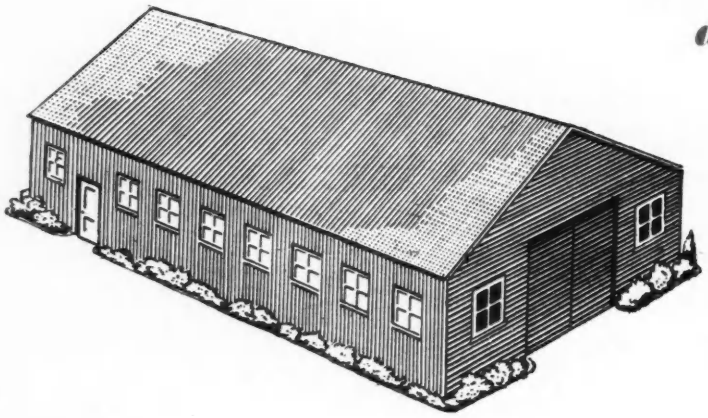

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A Seven-Day Journal

The Advisory Council on Scientific Policy

THE Advisory Council on Scientific Policy was constituted in 1947, with Sir Henry Tizard, F.R.S., as chairman, "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy." Its third annual report has been published this week, covering the twelve months April, 1949, to March 31, 1950, during which period nine meetings of the Council were held. The major issues of policy which the Council has kept under review are the arrangements for securing an adequate flow of scientific manpower to meet the needs of both Government and industry, and the appropriate organisation for scientific research within the Government. On the subject of manpower, the report suggests that the point is being approached at which the short-term demand for trained scientists may be satisfied, but where temporary maladjustments may occur. Taking the longer view, however, the Council stresses the need for a greater supply of qualified scientists if the fullest use is to be made of scientific research in industry. The Council says that it is impressed "by the much larger proportion of the populations of other industrial countries who receive a training in science or higher technology, and by the much wider use of scientifically-trained men in industry." If British industry, the report observes, is to improve or even maintain its present position in the world, it will have to employ more scientists and engineers both in the conduct of pure research, and still more in its application. The Council thinks, therefore, that great advantages might result from a more general adoption of the practice abroad of employing, in leading executive positions, highly qualified scientists with administrative ability and, in addition, of beginning to employ scientists of lesser calibre in technical positions which, in this country, have not so far been regarded as worthy of a professionally qualified man. Changes of this kind are essential, the report suggests, if scientific methods and the results of scientific research are to be fully utilised in solving the grave economic problems with which the country is confronted.

The Pressed Metal Industry Productivity Team

THE unanimous report of the specialist team from the pressed metal industry, which recently visited the U.S.A., under the auspices of the Anglo-American Council on Productivity, gives reasons for the greater production of American press plants and makes recommendations for increasing production in this country. It emphasises the American recognition that more goods produced at lower cost leads to greater consumption, more production and higher wages and that a better standard of living in Britain is linked with greater production at lower costs. The report states that there are no trade union restrictive practices limiting earnings and no restrictions to the up-grading of workers, while piecework prices are in no way related to total earnings. Other points mentioned are the close liaison between product and tool designers having special reference to cost and practicability of manufacture and the positive attitude in America towards up-to-date equipment, which contrasts with the British attitude of regarding machines as a long-term investment. American plant is worked to full capacity for a short life and is replaced, this cycle being linked with the shift system. The larger scale of production allows of a much greater degree of mechanical handling with its saving of labour than would be possible in Britain and the team particularly noted that whereas in Britain safety precautions are extensive and practically foolproof, the American approach is to train operators to be safety conscious so that with guards removed there was an increase in productivity of approximately 20 per cent. The report describes plant lay-out, production flow and a section deals with handling of materials, stressing that in America great efforts are made to keep everything moving by employing numerous mechanical aids. In the conclusion the position is assessed and certain improvements advocated, including the formation of an association of firms in the pressed metal industry for the interchange of ideas and for research into problems of technique and method.

Congress of Radiology Technical Exhibition

A TECHNICAL exhibition is being held this week, closing at 1 p.m. to-day, Friday, in conjunction with the Sixth International Congress of Radiology, at the Royal Horticultural Society's Halls, Westminster, S.W.1. Normally this congress takes place at intervals of three years, each time in a different country, but due to the intervention of the war, this exhibition is the first of its kind since 1937. In the meantime rapid progress has been made in almost every branch of X-ray engineering: for example, all present-day equipment, unlike its pre-war counterpart, is electrically safe and subject to reasonable precautions on the part of the user, there is no danger of X-ray injuries. Among the eighty exhibitors are manufacturers of X-ray apparatus from the following countries: Belgium, Canada, France, Germany, Great Britain, Holland, Italy, Sweden and the U.S.A. Whereas the use of X-rays was, at one time, confined almost entirely to the diagnosis of bone injuries, and the detection of foreign bodies, radiology is now regarded as an invaluable aid in many branches of medicine. With the help of apparatus shown at the exhibition abnormalities of the stomach, chest and arteries can be detected and, in dentistry, hidden causes of pain can be revealed. Among the more highly specialised pieces of equipment for particular branches of radiology and radiotherapy are a 24 MeV betatron, cine-radiography apparatus for taking "moving" X-ray pictures, tomography units for taking pictures of layers of the body. The accessories and materials exhibited include X-ray film and preparations designed to make visible soft body tissues which are normally not sufficiently dense to yield an X-ray image. Although the exhibition is mainly concerned with the medical uses of X-rays, some of the exhibits show a few industrial applications, such as the examination of metals and the analysis of crystals. The exhibition is not open to the public.

R.A.F. Short Service Commissions

A RECENT Air Ministry scheme is to grant short service commissions in the technical branch of the R.A.F. to selected technicians from the leading industries to enable them to acquire knowledge of the maintenance and operation of aircraft and associated equipment. The normal age limit will be 27 years, and candidates must have served an apprenticeship, possess the school certificate and have at least passed the examination for Higher National Certificate or its equivalent. Upon entry they will have initial training in the duties and responsibilities of an officer and in the elements of the technical organisation and administration of the R.A.F., followed by employment on technical duties in accord with their civil qualifications. The commissions are for five years and upon completion of service officers will be granted a gratuity of £500 and return to civilian life. It is considered that the period spent in the R.A.F. will have enhanced the qualifications and broadened the background of the men selected and that experience in handling the extensive equipment of a modern air force will enable technicians to take up a suitable post in the mechanical and electrical engineering industries. Although it is mainly intended that short service officers should return to civil occupations, a few may be considered for permanent commissions. The scheme is an example of the Air Ministry's policy of dovetailing its manpower requirements with those of industry.

The Institute of Physics

AT the annual general meeting of the Institute of Physics, held on July 20th, Professor W. E. Curtis was elected President and Professor E. G. Cox Vice-President, and Professor H. W. Thompson joined the board to represent the Faraday Society. The 1949 report recorded an increase in activities and of 202 in membership, to make the total 3657, and also mentioned the inauguration of the Education Group and North-Eastern Branch to form the seventh specialist subject group and eighth branch. The activities of the fifteen groups and branches are listed and include a note to the effect that the Australian branch held thirty-nine meetings. The Buxton Convention held in May was the outstanding event of the year, 420 members and their ladies attending. Concerning educational matters, the courses arranged in nine colleges in England and Wales for National Certificates in Applied Physics have been approved, arrangements have been made with the Scottish Education Department for the establishment of similar courses, and the Institute has collaborated with the Universities of Bristol and Cambridge and University College, London, in summer schools in special branches of physics. Dealing with publications, the report states that a further volume was added to the "Physics and Industry" series, a second edition of the "Handbook of Industrial Radiology" was issued and also a selection from the "Laboratory and Workshop Notes," extracted from the "Journal of Scientific Instruments." During the year the executive officers have dealt with many questions of professional moment and the board have been actively concerned with a number of Parliamentary Bills.

Industrial Coal Consumers' Council

THE report of the Industrial Coal Consumers' Council for the year ended June 30th, submitted by the chairman, Sir Ernest Smith, C.B.E., to the Minister of Fuel and Power covers the questions of coal production, supplies, quality, prices and service charges. It notes that increased coal output, aided by some withdrawal from stocks, has helped toward the recovery of the export market, but that output is still insufficient to meet all overseas demands for coal or to permit a limited freedom of choice of quality. The quantity of dirt being raised is deprecated, and disappointment is expressed in the report that the increased rate of production of deep mined coal has not been maintained. The installation of more and improved cleaning plant involving considerable expenditure is welcomed, but it is felt that more could be done, at the coal face and on the picking belts, to provide cleaner coal. It is pointed out that high ash coal can be used efficiently in plant specially adapted but there must be consistency in supply. The importance of the price of coal in the nation's economy is mentioned, and linked with the necessity of increasing productivity with reduced pit prices. A case is put forward for selling coal with high ash or excessive moisture at a reduced price so that consumers near the pits would use these coals. The report reviews the standard conditions of sale, and comments upon the service and loading charges. The Council reports on discussions during the year concerning the price structure, emphasises the importance of efficiency in the use of fuel and takes note of the fact that coke supplies for the steel industry were adequate.

Productivity in British Industry*

No. VIII.—WORKS EXTENSIONS—Part 1

By C. K. F. HAGUE†

IN heavy engineering in general, and with the manufacture of steam generating plant in particular, it is almost impossible to arrive at a simple yardstick by which increased output can be accurately measured from year to year.

In surveying the progress made by such a firm as Babcock and Wilcox, Ltd., we have to take into account the high degree of anticipation necessary when determining the installation of new heavy capital plant. A number of factors are concerned. The persistent endeavour to improve the overall thermal efficiency of steam power stations focuses attention upon the ever-increasing pressure and temperature at which the boiler is to operate, bringing in its train very complex metallurgical problems. The cost of a high-efficiency boiler plant at high temperature and pressure increases substantially if the price per pound of steam generated is the yardstick, but this measurement has to be corrected for the changing quantity of heat transferred to each pound of water under the varying final pressure and temperature conditions and the feed water temperature. The economics of power station construction places emphasis upon the need to build very large units, which has a tendency to reduce the cost per pound of steam in any comparable instance, but this reduction is partially offset by increased site constructional costs. The very high capital cost of a large boiler plant makes it most desirable to obtain lengthy periods of operational service, and the technical features consequent upon high availability have a considerable influence on design and through design on the manufacturing resources which have been made available at the works.

During the last twenty or thirty years the cost of fuel in many parts of the world, and particularly in the United Kingdom, has directed attention to the need to burn at a high efficiency much of the previously discarded residues from the collieries, and in those countries where oil is more generally used the development that has taken place on refinery processes has imposed upon the boilermaker the need to burn effectively the more difficult oil residues. The combustion problems arising from many alternative fuels are both complex and contradictory and bring considerable repercussions to the manufacturing side of the boilermaking business. The alternative methods of firing solid fuel necessitate that a wide range of equipment be made available to the user, and the handling problems associated with the high coal consumption rates all have their effect on confusing any direct comparison between one plant and another. By making many corrections to basic data helpful approximations can be made; but in a competitive world it seems abundantly clear that the only effective method of judging the degree of success or failure attending the efforts of the manufacturer is to ascertain whether the plant offered is superior in design, performance, materials and workmanship, and whether such plant represents in the opinion of the buyer the best value.

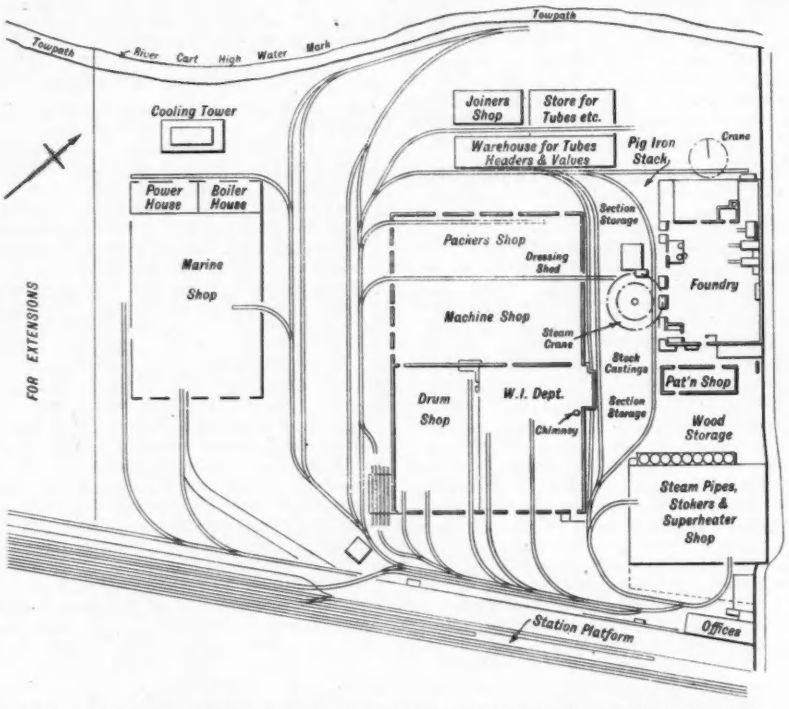


FIG. 1—PLAN OF ORIGINAL RENFREW WORKS OF BABCOCK AND WILCOX, LTD.

The Renfrew Works

The Renfrew works of Babcock and Wilcox, Ltd., were established about fifty-four years ago. At that time the works occupied a square piece of land of approximately 5 acres, and comprised foundry, machine shop, drum shop and forge. The plan of the original works is shown in Fig. 1. The growth of the works, with its gradual modifications to lay-out, became necessary, not only on account of the increased volume of the work to be produced, but also on account of the gradual changes in the size and nature of the product already referred to, as well as the addition of much ancillary equipment. For instance, when the works were originally established a water-tube boiler was considered to be large if designed for an evaporation of 6000 lb of steam per hour, at about 70 lb per square inch pressure with saturated steam. The majority of the boilers at that time were hand-fired and operated with natural draught chimneys, so that the amount of ancillary equipment required was confined to the connecting pipe-

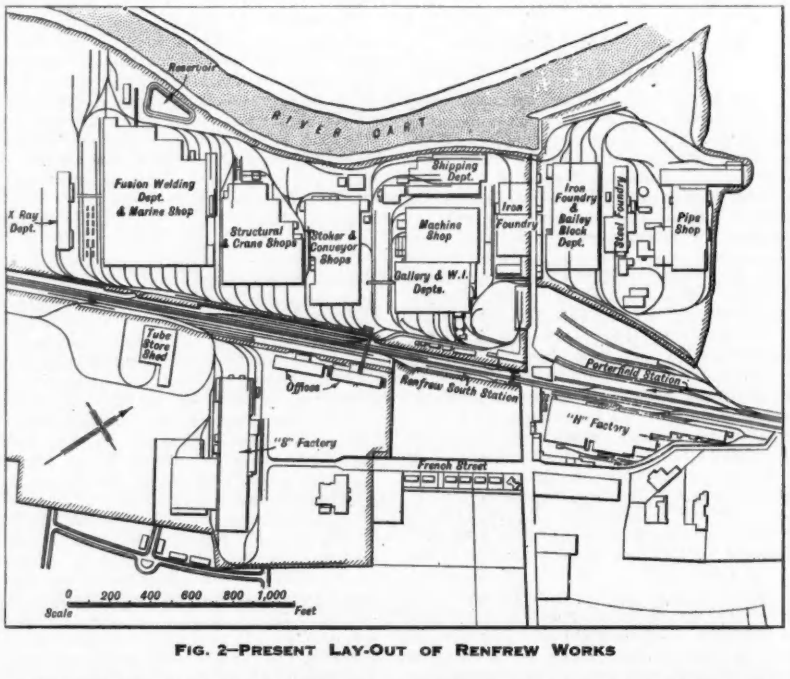


FIG. 2—PRESENT LAY-OUT OF RENFREW WORKS

* No. I, "An Introductory Survey," by B. White, appeared February 17th; No. II, "The Threshold of Productivity," by F. A. Martin, March 3rd; No. III, "High Productivity and Production Costs," by Sir Claude Gibb and Gordon M. Baker, March 17th; No. IV, "Standardisation in the Aircraft Industry," by E. C. Bowyer, March 31st; No. V, "Restrictive Practices," by Arthur Woodburn, April 21st; No. VI, "Research for Productivity," by Dr. D. F. Galloway, May 19th; No. VII, "Consequences of Simplification," by W. D. King and H. Sherburn, June 30th.

† Managing Director, Babcock and Wilcox Ltd.

work to the prime mover and the feed pump.

To-day, large steam generators are designed for an evaporation up to 1,000,000 lb. of steam per hour. Pressures have increased to 2000 lb per square inch and superheated steam temperatures to 1050 deg. Fah. Ancillary equipment is necessary, such as mechanical coal and ash-handling plant, firing equipment of many types, water wall furnaces, superheaters, economisers, air heaters, attemperators and all the complicated arrangements of integral pipework, plus that required for steam feed and blowdown circuits. Therefore the works as originally laid down has had to undergo tremendous modifications and expansion in the course of the last half century. In considering the manner in which these changes were progressively made, the nature of the original site needs to be emphasised. The works are situated on a somewhat narrow strip of ground lying between the River Cart and the railway track connecting Paisley and Renfrew. Consequently, expansion has had to take place either in a north-easterly or a south-westerly direction. No other was possible. Only when an entirely new factory is being laid out has the management a free hand. When the site is already partly built up and when its boundaries are already fixed the problem of choosing a new lay-out or designing a new extension becomes one of finding the best among a number of possible compromises.

The original lay-out at Renfrew was planned so that practically all traffic to and from the works, and all internal traffic, should be railborne, since at that time road transport capable of handling heavy loads efficiently did not exist. The present lay-out of the works is shown in Figs. 2 and 3. Comparison with Fig. 1 shows clearly not only how much expansion has taken place, but also that the original lay-out had to be changed. It was obviously necessary, for instance, to transfer certain manufacturing processes to new sites as the works were extended. It will be seen from Figs. 2 and 3 that the original works became the central machine shop and the forge in the present lay-out. In the endeavour to maintain an effective lay-out of each department with the other many considerations had to be taken into account. One of these was prohibitive cost of changing the position of the large capital plant. It was not always possible to effect other than a compromise solution. Another important consideration in the gradual evolution of the works was that of internal transport. Whilst the original idea of utilising rail traffic to the maximum has been maintained, a system for road transport has also been gradually developed, and thus the rail system is now augmented by the various other modern methods of transporting material. If in the extension and development of a works upon a restricted site compromises have necessarily to be accepted, there are certain matters upon which no compromise is permissible. Easy access, for example, between feeder shops, such as the iron and steel foundries, the forge and the central machine shop, and the various other departments using their products, must be maintained. From Fig. 2 it will be noted that at Renfrew the transport of material from the iron and steel foundries to the central machine shop is relatively quick and easy, since these shops are adjacent. Furthermore, the forge is actually in the same main building as the central machine shop. The transport systems are also shown on Fig. 2 (rail and road). An additional major consideration, sometimes overlooked, is that of providing all the necessary and extensive services to various parts of a works when an existing lay-out has to be altered, a matter often of some complication. If hydraulic power is required, as at Renfrew, it means that an extensive system to supply water under pressure to the many presses throughout the works is necessary. The central pumping station at Renfrew delivers water at 2500 lb per square inch pressure to all departments, and the lay-out of the hydraulic system is shown on Fig. 3. It has been gradually developed, the main pump house having been built in 1931. Originally, electrical power was generated in a small power plant, but in 1934 it was decided to close this plant down and obtain power from the Clyde Valley Power Company. At the present time electricity is taken from the B.E.A. system at 11,000V and transformed to 440V in five sub-stations in various parts of the works. There is still a certain demand for direct current, and motor converters and rectifiers are used to provide this supply. A diagram of the electrical system is shown in Fig. 4. It illustrates the complexity of the system needed to serve a large factory. Any extension or change of lay-out is necessarily influenced by, and itself influences, such an extensive system.

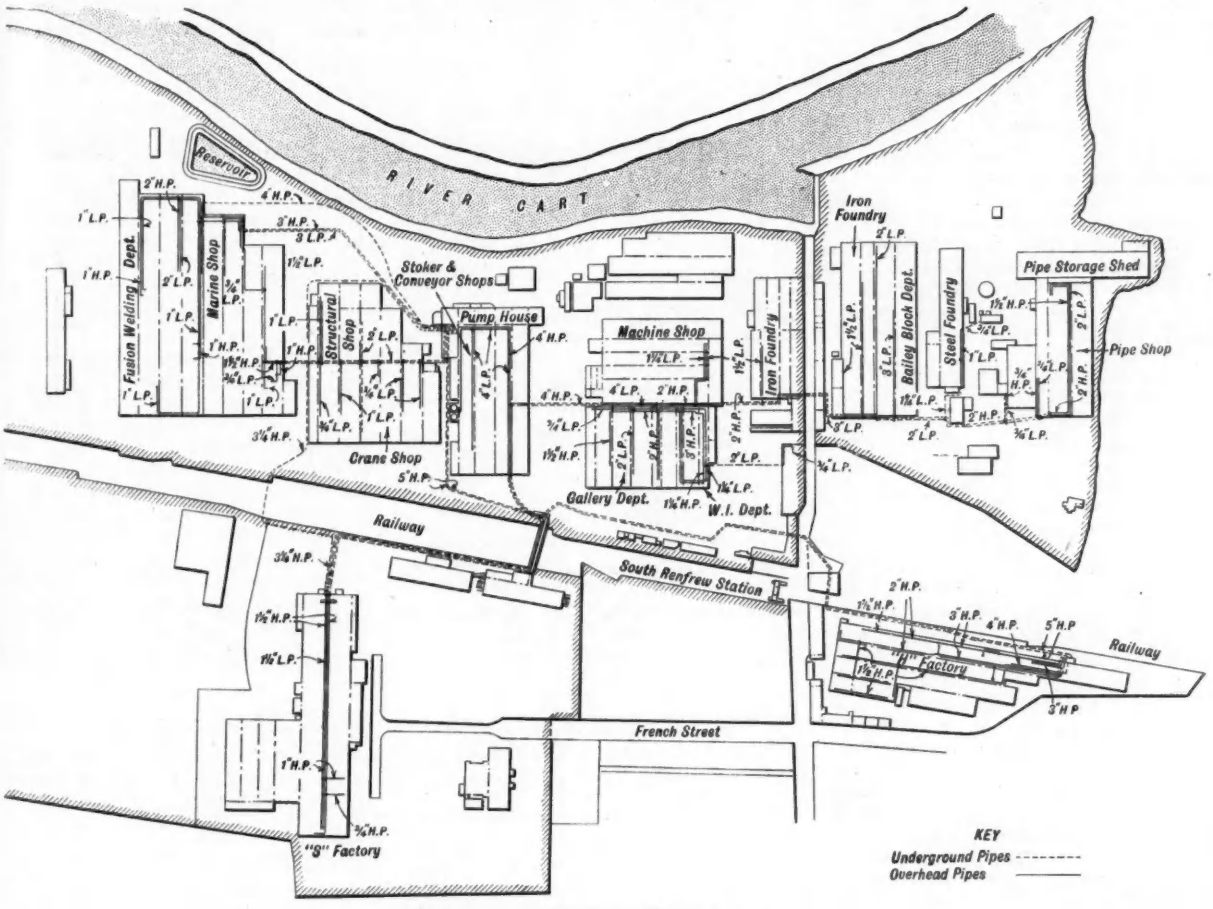


FIG. 3—ARRANGEMENT OF HYDRAULIC PIPES

Apart from the foregoing services, there has also had to be a gradual development of the heating system in all departments. Furthermore, with the development over the years of greater care for the health and comfort of employees, space has had to be found for up-to-date canteen facilities, locker rooms and lavatory accommodation, and a medical service with surgeries and X-ray equipment.

It is impossible in the space available to

describe and comment upon changes in all parts of the Renfrew works, but recent developments in some of the main sections will illustrate the steps which have been taken to increase both production and efficiency.

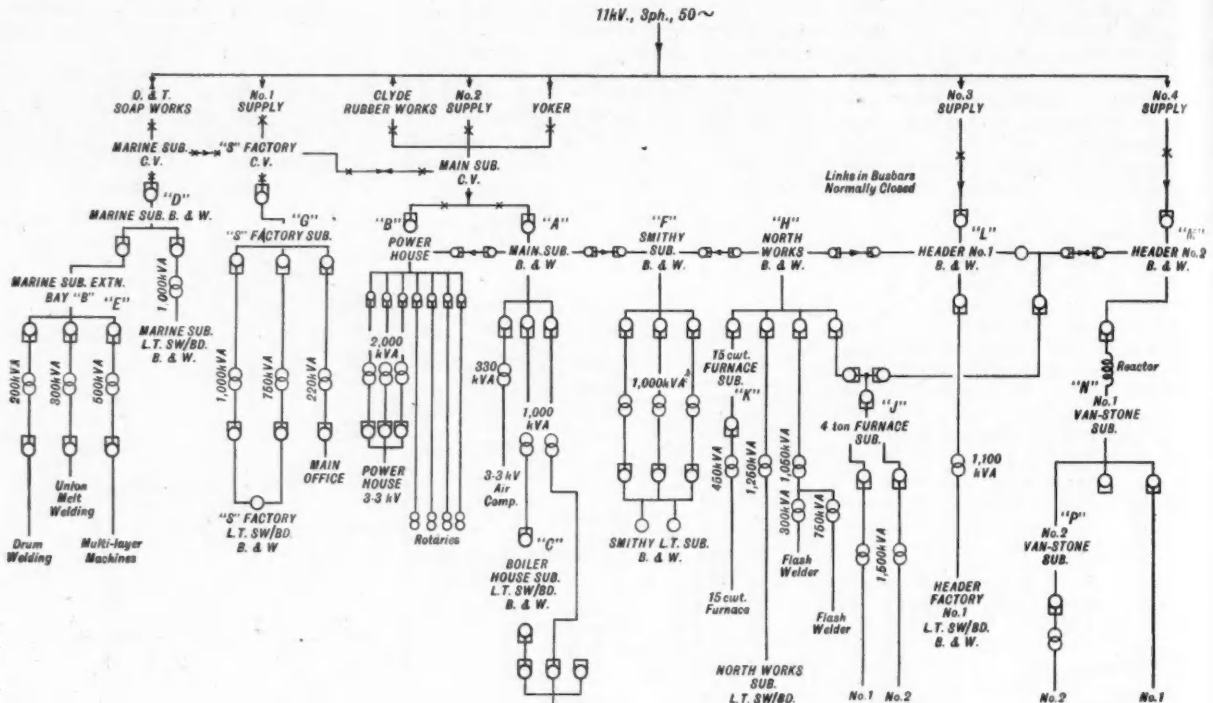


FIG. 4—DIAGRAM OF ELECTRICAL SYSTEM

IRON AND STEEL FOUNDRIES

The lay-out of the iron and steel foundries is shown on Fig. 5. The ironfoundry is much larger than the steelfoundry, and, as will be seen from the diagram, the raw material intake is at the rear of the shop and progresses to the melting unit located centrally. The melting unit comprises five cupolas producing 600 tons of molten metal per day. The molten metal is distributed throughout the shop to the several moulding units. The continuous casting plant produces approximately 16,000 castings per day, all of which are of a repetitive type, reasonably light and produced in boxless moulds. A new mechanised unit has been installed for the production of heavier castings in boxes, and this unit is adjacent to the continuous casting plant. The range of castings produced on this unit varies from a few pounds to 30 cwt and up to the limits of a 5ft square moulding box. This unit comprises sand preparation plant, delivering conditioned sand to six roll-overs, two sand slingers and four squeeze machines. The boxes are conveyed from the machines on roller track conveyors for casting, thence to knock-out, the new sand being returned to the system. All labour is engaged on direct piecework, the system embracing the earnings for each team per machine which are divided proportionately between the labour engaged. Prior to the installation of the plant the various producing units were rather widely distributed throughout the shop, and the improved results that have been obtained by the reorientation of the plant and the introduction of additional equipment may be assessed by making a comparison between the results obtained. The output per skilled worker has been increased by 300 per cent. This increased output applies equally to the number of castings as well as total weight. The quality of the casting has improved and the operatives' earnings have increased. A recent addition is the hydro-blast equipment in the dressing shop, which has substantially improved the conditions under which the operatives work, whilst at the same time introducing a saving of 20 tons of sand per week. New modern grinding equipment has been installed, to-

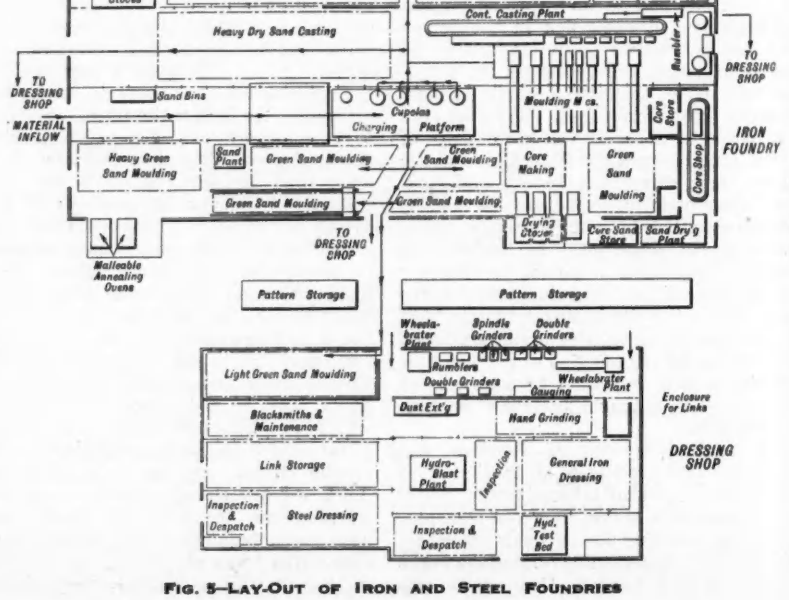


FIG. 5—LAY-OUT OF IRON AND STEEL FOUNDRIES

gether with an up-to-date dust extraction plant, which has greatly improved the atmospheric conditions, and it can be claimed that the foundry compares favourably with any other shop at the works. Considerable attention has been paid to the amenities within the department, and it is hoped that new entrants to the foundry will be of a higher standard than was obtained in the past.

The steelfoundry is situated close to the ironfoundry and the raw material inflow is also at the rear of the shop. The melting unit consists of three electric furnaces, with a combined melting capacity of approximately 35 tons per day. New sand handling plant and conveyors are being installed, and the moulding equipment is being re-arranged on similar lines to that which has already proved so successful in the ironfoundry. Heat-treatment is carried out in the department, and new furnaces are being installed to meet the more exacting specifications now to be fulfilled. These, in turn, are a direct result of the increased pressure and temperature at which modern boiler plant has to operate. At the rear of the shop a section is devoted to the manufacture of special alloy castings, the space utilised being an extension made during the war for armament purposes and not specifically for the operations now carried out.

(To be continued)

North of Scotland Hydro-Electric Schemes*

No. II—THE LOCH SLOY PROJECT

PART II—*(Continued from page 60, July 21st)*

MAIN TUNNEL AND SURGE SHAFT

THE main flow of water from the reservoir to the power station passes from the intake at the foot of the intake tower, into a bell-mouthed section leading under the dam from the gate opening in the tower (see Fig. 17, Part III), measuring 19ft by 10ft, to a steel pipe of riveted construction, 13ft 6in in diameter. This pipe is embedded in concrete in a trench passing under one of the buttresses; it falls gradually to obtain greater head of rock for tunnelling, and turns towards the tunnel entrance in the high ground on the left bank of Inveruglas Water, which it joins about 80ft downstream of the dam.

The first section of the tunnel continues into the mountainside in the same direction until sufficient cover of rock is obtained, and then turns towards the surge shaft. At this point the construction changes from a circular section 13ft 6in in diameter with a reinforced concrete lining, into a horseshoe section with a maximum width of 15ft 4in (equivalent diameter about 15ft 8in) with a plain concrete lining. Both types are shown in cross section in Fig. 9. The first section of tunnel, with the circular section, is about 700ft long. It is reinforced with mild steel hoops formed by welding together two semi-circular pieces and laced together with longitudinal rods.

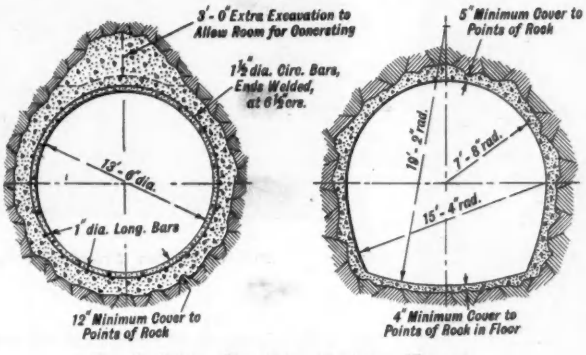

3'-0" Extra Excavation to Allow Room for Concreting
1½" dia. Circ. Bars, Ends Welded, at 6½" ctrs.
13'-6" dia.
1" dia. Long. Bars
12" Minimum Cover to Points of Rock
5" Minimum Cover to Points of Rock
19'-2" rad.
7'-8" rad.
15'-4" rad.
4" Minimum Cover to Points of Rock in Floor

FIG. 9—CROSS SECTION OF MAIN TUNNEL

The rest of the main tunnel has a length of about 8200ft and passes under Ben Vorlich, which rises about 1700ft above the tunnel invert. It has been driven through mica schist, the same type of rock as in the dam foundations, for practically its entire length. When faults and soft regions were encountered, the tunnel was lined with a supporting framework of steel joists, and occasionally with dry walling. These supports were left in place and concreted in when the tunnel was lined.

All the weak places in the rock, where these measures were necessary, were pressure grouted, and grouting was carried out along the entire crown of the tunnel.

The work was carried out from four faces—from the exit portal, from two faces working in opposite directions at an intermediate adit, and from an adit close to the dam. The last-mentioned adit was used only during the construction of the circular section of the tunnel. Each face was worked by first drilling to a depth of about 7ft from a drill carriage mounting nine high-speed drills. About seventy holes were drilled. The face was then blasted with gelignite and the spoil was loaded by mechanical loader and hauled out.

At one point the tunnel passed into loose block material formed by the intersection of two major faults and a cavity about 50ft high resulted from successive roof falls. It was decided to by-pass this cavity by diverting the tunnel, which was thus curved along a length of about 175ft, being offset a maximum distance of about 75ft from its original line. In spite of this diversion, the tunnel faces joined with an error of about 1in.

The main tunnel near its outlet passes underneath the surge chambers, to which it is connected by a vertical surge shaft, as shown in Fig. 8. About 500ft from the exit portals the tunnel bifurcates into two circular sections, each lined with a steel pipe 10ft in diameter backed with concrete. The pipes are sufficiently strong to resist the full water pressures, the cover of rock diminishing gradually over this length. At the exit portals there are steel pipe-lines about 1500ft long leading down a steep slope to the power station about 650ft below.

The surge shaft is situated about 500ft inside the fork of the main tunnel; it is designed, in conjunction with the surge chambers, to limit the effects of water hammer and vertical swing of water under the worst conditions of rejecting or throwing on load at the power station. It is a vertical shaft, 245ft high from the invert of the tunnel to the floor of the top expansion chamber, and 26ft in diameter and lined with concrete. The surge chamber at the top of the shaft is 90ft long by 38ft wide, and is constructed with a vaulted roof, being 28ft high at the centre of the vault; it also is lined with concrete and the whole of this vaulting is hewn out of solid rock inside the mountain.

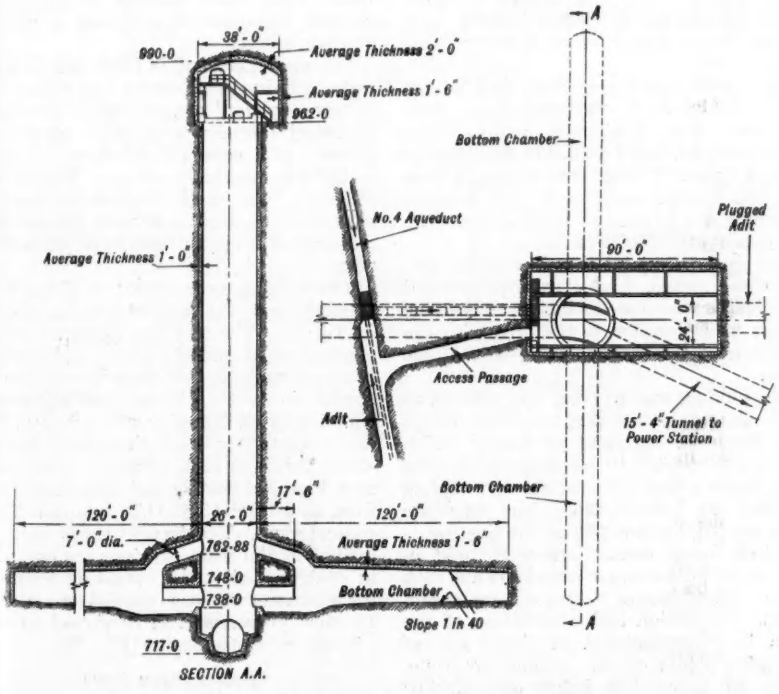


FIG. 8—ARRANGEMENT AT SURGE SHAFT

*No. I, "An Introductory Survey," appeared July 14th.

The chamber was constructed from an adit at floor level, which was plugged on completion of the work. Shafts were driven upwards from this adit to the roof level of the chamber, and then joined together to form the vaulted roof. Trenches were then excavated to allow the concreting of the walls of the chamber. The roof was next concreted, with shuttering supported on the rock hearting, and then the remaining rock was excavated. A gantry for a 2-ton electric crane is provided in the completed surge chamber.

A short tunnel was driven to this chamber for construction and later for inspection and maintenance, and it is also joined by a collecting tunnel 4500ft long from the Allt Ardvorlich stream, it being more convenient to collect the water from this stream by a tunnel direct to the main tunnel than to join it to the northern system of aqueducts which flow into the north end of Loch Sloy.

For the construction of the surge shaft a zig-zag stope for removal of spoil was first driven up from the main tunnel to the top chamber, close to the centre line of the surge shaft. The surge shaft was then constructed

FIG. 10—MAIN TUNNEL AND LOWER SURGE CHAMBERS

from the top downwards, a length being first excavated and then the concrete lining placed. The 2-ton crane in the top chamber was used for some of this work.

The expansion chamber at the bottom of the surge shaft is divided into two equal halves, one connecting with the shaft on each side at a level just above the main tunnel (see Figs. 8 and 10). Each half of the bottom chamber is similar in cross section to the main tunnel, but with a diminishing height, the roof and floor being sloped.

THE PIPE-LINE

The two 10ft diameter steel pipes at the tunnel exit branch into four pipes, each with an internal diameter of 7ft at the top of pipe-line reducing to 6ft 4in at the power station. Each of these pipes supplies one of the four main turbo-alternators. The pipe-line is about 1500ft long, with four large anchor blocks of reinforced concrete at the principal changes of direction or inclination. The uppermost anchor block supports a valve house at the commencement of the pipe-line, and the lowest block is at the power-house. From the tunnel portal to the valve house the pipes are encased in concrete. In between the anchor blocks the pipes rest on concrete piers spaced at 48ft centres, and are gently curved with horizontal or vertical curves of 1500ft radius where required. An inclined service railway runs up beside the pipes to the valve house at the top, which is equipped with a 25-ton overhead travelling crane and servicing space.

The pipes were designed to withstand a maximum pressure of 510 lb per square inch (400 lb per square inch being due to a head of 910ft and the remainder to surge rise and water hammer), and were tested both in the shops and on the site after jointing to a pressure 50 per cent in excess of the working pressure.

Their thickness varies from $\frac{11}{16}$in at the top to $1\frac{3}{16}$in at the bottom; they were fabricated from mild steel plates, three plates being bent and welded in the shops to make a pipe 24ft long. The length of each pipe was limited, however, to give a maximum weight of 15 tons, the total weight of the pipes being over 3500 tons.

The pipes were jointed at the site by outside cover straps, double or triple riveted depending on the plate thickness, thus giving a flush inside surface to the pipe with the exception of the countersunk heads of the rivets.

Site welding and riveting was reduced as much as possible. Thus, the cover straps were made in semi-circular halves which were shop riveted to adjacent pipes, the joint being completed on site by welding together the halved straps (the only site welds needed) and completing the riveting.

Bolted flange connections were used in place of the butt straps at certain points, such as the connections at valves and expansion pieces. Expansion and contraction of the pipes is accommodated in three sets of expansion joints of the stuffing-box type, which are fitted just below each anchor block. The pipes rest on phosphor-bronze strips in a metal saddle at each pier, thus allowing longitudinal movement to take place.

THE POWER STATION

The Loch Sloy power station is intended to be the control centre for several of the Board's undertakings, four high-head stations, with a group production of some 300 million kWh annually, having been planned in the area. Thus, in addition to the machinery hall, the south end of the power station is taken up by an administrative building. This part of the power station is of steel-framed reinforced concrete construction, and contains offices, stores and a repair shop, together with the local l.t. switchgear and a control room overlooking the machinery hall. The entire building is faced with precast facing blocks, which have been brushed to expose the granitic aggregate, thus giving a pleasing exterior surface.

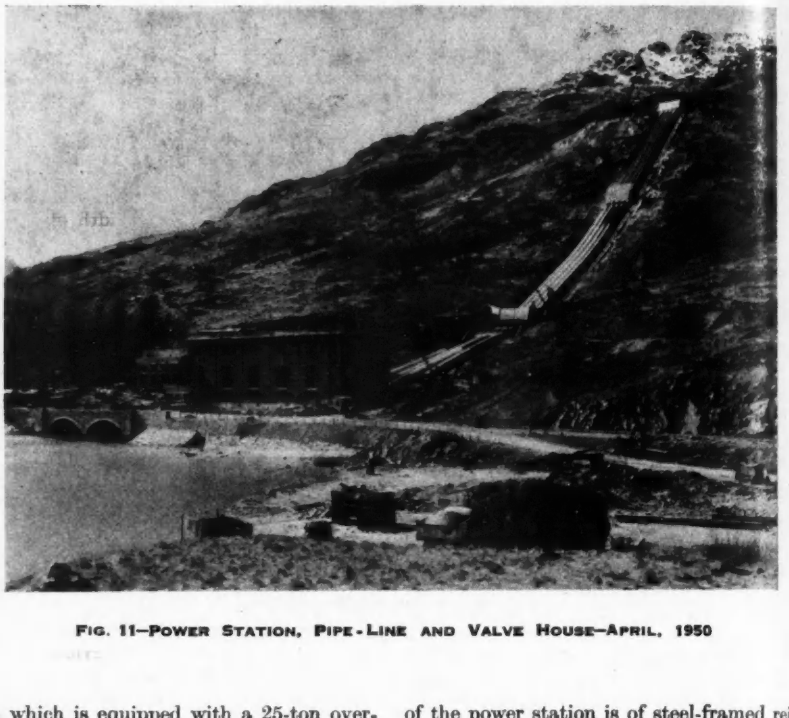


FIG. 11—POWER STATION, PIPE-LINE AND VALVE HOUSE—APRIL, 1950

The machinery hall is 190ft long and 52ft wide, and is a steel-framed structure with lightly reinforced concrete walls 12in thick. The steel framework is made up of rigid portals, with columns and beams to carry a 120-ton overhead crane. During construction, the steel framework was first erected and roofed over with precast slabs and asphalt, to permit early operation of the crane.

The main sets are spaced at 35ft centres, the operating floor being at 33 O.D., as shown in Fig. 13. The auxiliary Pelton wheel set is at the south end of the hall, and provision has been made for the future installation of a second similar set. These auxiliary sets are supplied by an 18in pipe with a branch from each main pipe with a hydraulically operated sluice valve on each branch. Above these sets there is a loading and dismantling platform at a level of 51 O.D. adjacent to the control room. The draught tubes and spiral casings of the main turbines are embedded in concrete below the operating floor, and the alternators are each carried on a pedestal 7ft high, constructed in reinforced concrete with an inner steel frame (Fig. 13).

GENERATING SETS

The spiral casings of the turbines are of steel cast in one piece, and are each of 30 tons

weight. The operation of the machines takes place by the governor actuator and servo-motor, which is completely automatic. A cross section of one of the main turbines is shown assembled at the makers' works in Fig. 12, and a turbine is shown assembled at the makers' works in Fig. 14. The turbines are directly and rigidly coupled to the generators above them, which are placed on top of the concrete pedestals on substantial bed-plates.

The alternators are of the "two-bracket" design, a combined thrust and guide bearing being mounted in the upper bracket above the rotor, and a second guide bearing mounted below the rotor in the lower bracket. Directly above the alternator are the main and pilot exciters, which are totally enclosed.

Open slots are stamped out on the inner periphery of the stator core plates to receive the winding. The stator winding is connected in star, with six main and six neutral leads brought out to heavy copper bar mica-bushed terminals, supported in brackets from the frame. It is a two-layer or basket winding with two circuits in parallel per phase, all coils being alike and interchangeable. There are two coil sides per slot each consisting of several conductors built up of copper laminations, suitably transposed through the winding to reduce eddy currents to a negligible amount.

The whole of the main insulation is of Class "B" quality in accordance with B.S.S. 226. Six embedded copper-constantan temperature detectors are provided in each parallel circuit of the stator winding between top and bottom coil sides and in the stator core and teeth.

A separate shaft bolted to the upper end of the main shaft carries the exciter armature, the slip-rings and the pilot exciter armature.

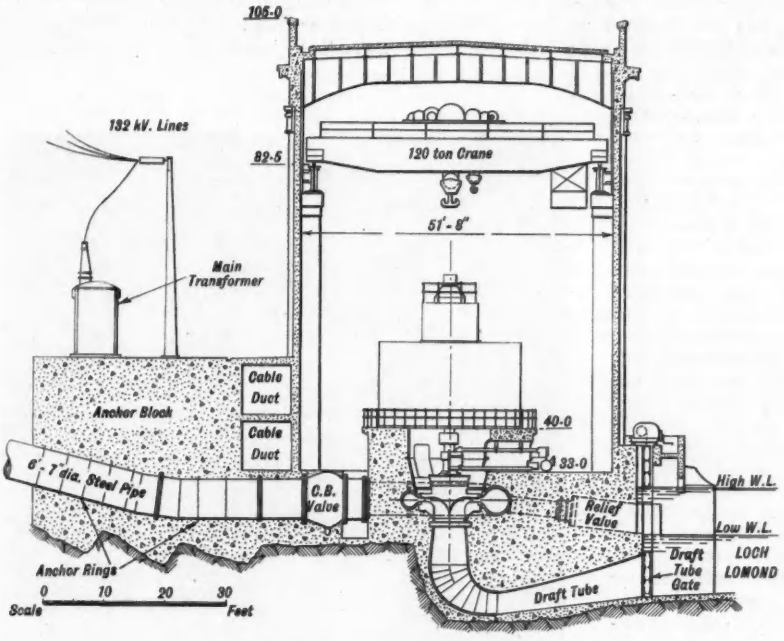


FIG. 13—SECTION THROUGH POWER STATION

through a thrust bell which is lightly pressed on the shaft and secured by keys. The bronze white-metal-lined pads are pivoted to enable them to tilt freely in any direction and are independently adjustable to ensure that each can be made to carry its proper share of the load.

Oil is circulated through the bearing continuously by a motor-driven pump with a stand-by pump. The level in the oil chamber is maintained at correct height by means of a weir so that in the event of temporary cessation of oil supply the set can continue to operate for about fifteen minutes without injurious heating. In normal operation the overflow from the weir passes through a sump which is capable of holding all the oil in the system, whence oil is pumped through an oil cooler to the bearing. Provision is made in the piping to permit drainage of the thrust oil chamber and also for the use of a centrifugal oil filter. The stand-by pump starts up automatically on failure of oil supply to the bearing.

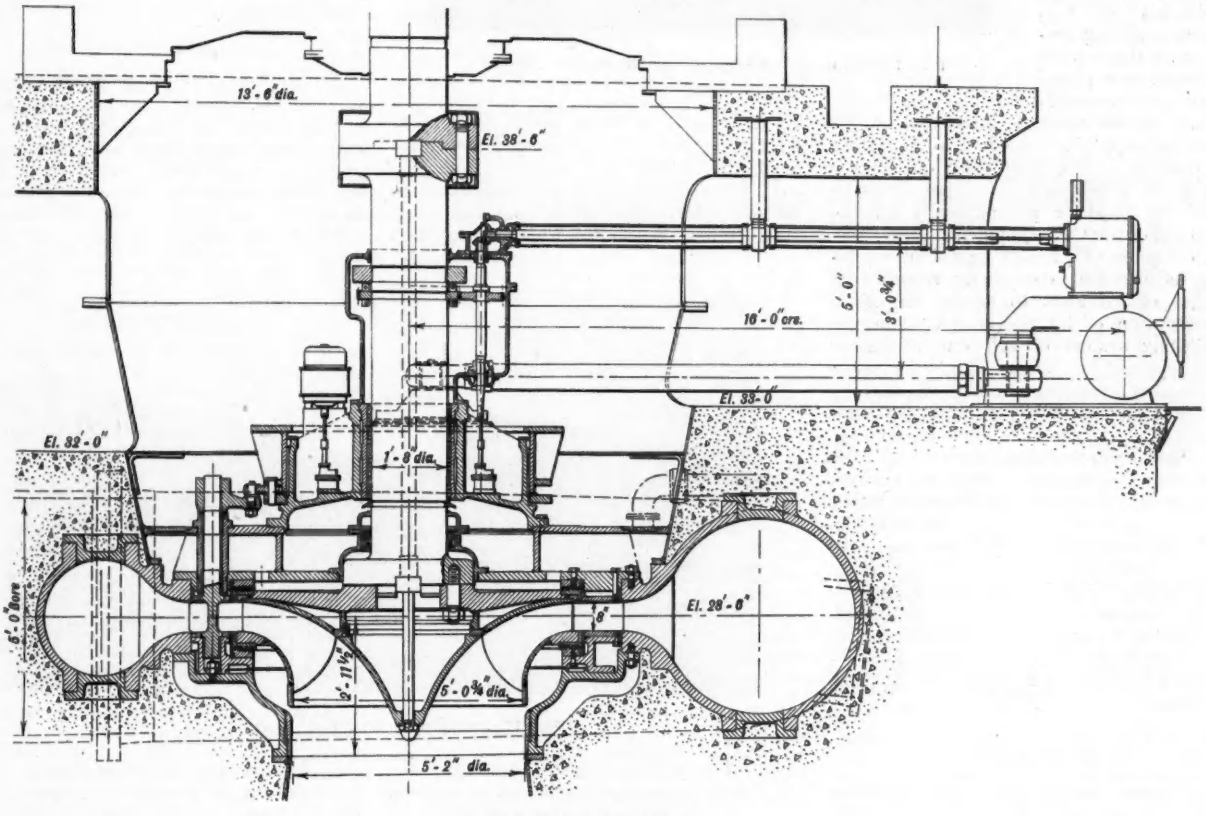


FIG. 12—TURBINE DETAILS

A thrust bearing of the pivoted pad type mounted on the upper bracket carries the whole weight of the revolving parts together with the hydraulic thrust, about 230 tons in all. The rotating load is transmitted

A second guide bearing is mounted in the

lower bracket between the rotor hub and the coupling. Each of the six arms on the lower bracket carries a braking and jacking cylinder, supplied from a ring main supported from the bracket. The ring main and the cylinders are designed for an oil pressure of about 2000 lb per square inch. The rams press against the underside of the brake pads, which are Ferodo lined and are normally held off by spring pressure. For braking a limit switch is fitted to the turbine governor so that the brake solenoid can only be energised when the turbine gates are closed. The alternator is self-ventilated, air being circulated in a closed circuit by the fans attached to the upper and lower sides of the rotor rim, the salient poles themselves assisting the fanning action. Part of the ventilating air is by-passed from the pressure chamber surrounding the stator end windings through ducts to ventilate the main and pilot exciters, the air afterwards being returned to the fan inlet. This compact system of ventilation is ideal for the application of CO_2 fire-extinguishing apparatus as the volume of air in the closed circuit is a minimum. In addition, air inlets and outlets capable of supplying heated air to the station are provided. The inlets and outlets are each fitted with doors which can either be closed by hand or automatically on the operation of the CO_2 equipment.

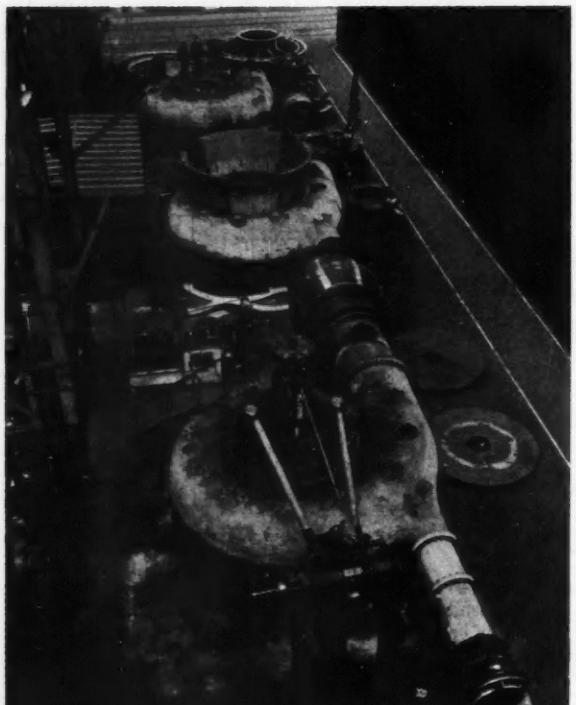


FIG. 14—TURBINE ASSEMBLED AT MAKER'S WORKS

A complete CO_2 fire-extinguishing equipment is installed comprising a sufficient number of cylinders to ensure an initial concentration of 50 per cent CO_2 in the ventilating system of any one alternator and 30 per cent for a period of thirty minutes by means of a delayed discharge of gas.

A normally inactive quick-acting automatic voltage-regulator equipment, mounted on a panel, controls the exciter voltage. The equipment is energised from a positive phase sequence network and includes power factor compensation for parallel running, line drop compensation and high and low-voltage protection. The automatic voltage regulator operates in conjunction with a motor-operated exciter field rheostat which is supplied for separate mounting in the regulator room. There is also a hand-operated pilot exciter field rheostat for panel mounting.

MAIN TRANSFORMERS AND AUXILIARY SWITCHGEAR

The main transformers and auxiliary switchgear are directly connected to the alternators without any 11kV switchgear. They are situated on the upstream side of the power station and are rated at 35,000kVA, 11/132kV, three-phase, 50 cycles. They are of the three-phase, water-cooled "OFW" type, fitted with off-circuit, tap-changing, with provision, if required, for on-load tap-changing on the windings to be added at a later date. The higher voltage winding is star-connected and arranged for operation with the neutral solidly earthed. There are also four 150kVA, 11,000/415V, three-phase, type "ON" outdoor auxiliary transformers.

Unit boards including contactor starters are used for essential turbine and alternator auxiliaries which are supplied from the auxiliary transformers directly connected to the alternator. The common services board feeds the station services, which are supplied from the auxiliary turbo-alternator set. As already mentioned, provision is made in the power station for a second auxiliary set.

132kV OUTDOOR SWITCHING STATION

From the main transformers at the Loch Sloy power station there are four 132kV overhead circuits terminating at the 132kV outdoor switching station at Inveruglas, which is shown in Fig. 15, and is approximately 1 mile from the power station. The switching station is a single busbar installation laid out generally in accordance with C.E.B. practice and will comprise four generator circuits and initially six feeder circuits, which will eventually be increased to nine. The station is divided into two sections connected by a bus-section breaker.

The circuit breakers are bulk oil dead tank units rated at 2500MVA, fitted with "multi-flow" arc control grids, and are provided with high-speed pneumatic closing mechanisms for which a common compressor house is installed housing two compressor equipments operating at 150 lb per square inch. The pneumatic mechanism combined with the multi-flow grids gives high-speed tripping with a total break time of 5 cycles.

Opening and closing control is carried out electrically by means of a supply from the battery on the sub-station site and normally the breakers are operated at the power station from remote control boards. Means are also provided for local electrical control at the circuit breaker.

The 132kV isolators are of the rotating centre-pillar, type manually operated but with remote indication of position, and they are suitably interlocked with the appropriate circuit breakers to ensure correct and safe operation.

An auxiliary plant building accommodates the battery referred to above, auxiliary a.c. and d.c. switchboards, and a relay board for the protective relays associated with the breaker circuits. In an annex to the auxiliary plant building is situated the oil-handling and purifying equipment for the oil in the circuit breakers. Means are provided by pumping plant and permanent oil piping to extract and purify oil from any circuit breaker tank when desired.

PROTECTION

The protection of the generator circuits is on the differential principle, designed to provide overall protection of the generators, main transformers and lines between the power station and switching station. High-speed carrier current protection is included on the various feeder circuits. The switching station itself and particularly the busbars and associated connections has a special form of bus zone protection operating on the "Casson Last" principle, incorporating vibrating relays which ensure high-speed operation of the protection in the event of a fault within the protected zone.

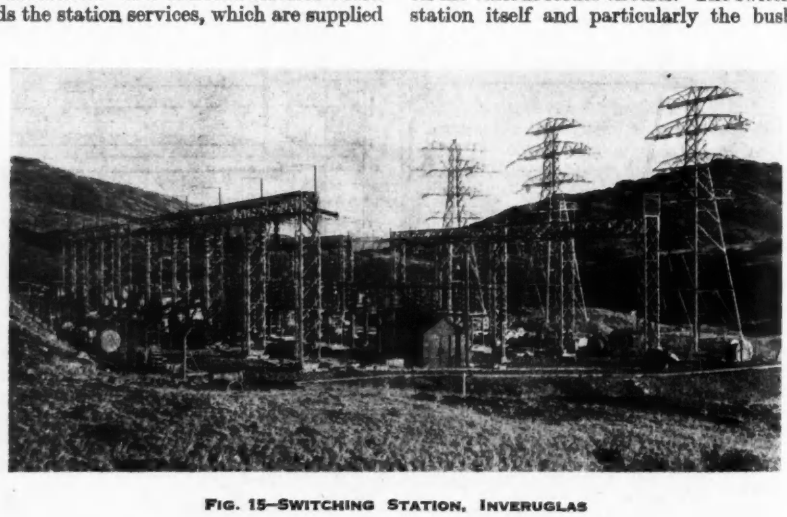


FIG. 15—SWITCHING STATION, INVERUGLAS

The control board in the power station for the switching station is of a novel type, and the controls, alarms, indications and syn-

chronising are all accomplished over a multi-core telephone cable. By this means it is possible to effect remote direct control of the switching station over the comparatively long distance between the power station and switching station.

(To be continued)

The B.B.C. Engineering Research Department

An account of the activities and aims of the B.B.C. engineering research department was given recently by Sir Noel Ashbridge, the Corporation's Director of Technical Services. Broadly speaking, the function of the research department is to solve the problems that arise in improving and extending the service on both sound and television, and to investigate and evolve new ideas and techniques which may be applicable to broadcasting. Its activities cover every phase of broadcasting, including work on studio acoustics, microphones and loudspeakers, recording, aerials and transmitters, field strength surveys and problems of coverage, v.h.f. broadcasting, and television. Normally, however, the work does not include the day-to-day problems of broadcasting.

The original home of the department was a converted convent in Nightingale Square, Clapham. During the war a medium-sized property on the outskirts of Oxford was acquired as well, and the work was carried on there and at Nightingale Square. At the end of the war a search was made for a new headquarters large enough to accommodate the whole department and, in September, 1947, the B.B.C. obtained an option to purchase Kingswood Warren, Banstead; by November, 1948, the first of the research sections began moving in.

Kingswood Warren is about 20 miles from London, just off the Reigate Road, and, with its large house and 27 acres of grounds, makes an ideal headquarters for research. The house has been modified internally and now accommodates nine laboratories, a television studio, a library and a drawing office. In what were the stables there are now workshops and stores. As the house is not large enough to accommodate the whole research department a new building has been erected alongside; it will become the home of the television section as soon as it is ready (in September this year, it is hoped). Part of the electro-acoustics section will then move into the house, the remainder staying on at Nightingale Square until more building work can be undertaken.

Research Programme

In the main the television section is concentrating on a precise evaluation of the possibilities of higher-definition systems and colour. For this purpose a vision channel has been developed and built, which can produce at will 405, 525, 625 or 819 line pictures having balanced horizontal and vertical resolution; it can also be used for determining the effects of restricted bandwidth and other forms of distortion on pictures having these standards of definition. Further, an experimental colour channel has been constructed to allow the engineers to gain first-hand experience of the potentialities and problems of colour television.

Of more immediate application are the experiments on co-channel interference between television transmitters. A thorough study of the interference resulting from transmitters on the same or neighbouring carrier frequencies has been made and the criteria for successful channel sharing have been determined. These results are of immediate importance, since the B.B.C. has at its disposal only five channels, which will eventually be shared between ten transmitting stations.

When the television section moves into the new building it will have at its disposal a studio comparable in size with the studios at Alexandra Palace. The studio will be equipped with scenery and lighting so that cameras can be tested under realistic conditions. There will also be a large viewing room, in which the reaction of audiences will be tested and an open-air studio on the roof for testing cameras on exterior scenes.

The development of the aerials for the new television transmitting stations and for v.h.f. broadcasting has been the main task of the aerial section since the war. The aerials for both these applications—the ring system for television and the slotted cylinder for v.h.f.—were developed with the aid of small-scale models, thereby obviating the costly modifications which might have proved necessary had the full-scale aerial been built before experimental confirmation of its probable performance had been obtained.

The model television aerials were built to a scale of 1 : 7·5 and tested in the grounds at Kingswood Warren over the band 445 Mc/s to 496 Mc/s with equipment developed for the purpose.

Field Strength Section

Another important activity of the research department, carried out by the field strength section, is the testing of sites for new transmitting stations by taking a mobile transmitter to the most likely sites and then touring the surrounding district with field strength measuring equipment. With the information obtained in this way a field strength contour map for the projected station is prepared, from which the probable coverage can be deduced. In prospecting for a television site, for example, a 1kW transmitter is used with an aerial suspended about 600ft above the ground by a balloon or, in rough weather, supported on a 110ft mast. The signal within the probable service area is then recorded continuously on a roll of paper as the field strength van cruises round. By linking the recorder to the wheels of the van the movement of the paper is determined by the distance travelled, so that the signal strength recorded at any point on the paper can be related to a definite position on a map. At the moment the field strength section is chiefly concerned with finding sites for new television stations, though some measurements of the field strength of medium-wave broadcasting stations are going on as well.

In 1945 the research department embarked on a series of tests designed to give first-hand information on the possibilities of v.h.f. broadcasting. While these tests, which were made with low-power transmitters, indicated that F.M. would be superior for this purpose, it was decided as a long-term project to carry out a further series of tests at high power. The high-power v.h.f. station at Wrotham, which was built for this purpose, has recently been completed and is now being used by research department for comparative tests of F.M. and A.M., in conjunction with a number of receivers built to the department's specification. In parallel with this work the performance of typical F.M. broadcast receivers and the propagation characteristics of v.h.f. transmissions are being studied.

An Anglo-Danish Telegraph Transmission Cable

On July 12th, His Majesty's Telegraph Ship "Monarch" completed the laying of a new submarine cable between Weybourne, Norfolk, and the island of Fanoe, off the west coast of Denmark. The cable will form an important link in the telegraph system of the Great Northern Telegraph Company, of Denmark, for whom it has been made by Submarine Cables, Ltd., at Telcon Works, Greenwich.

Besides being the first installation of a coaxial cable specifically to provide voice frequency telegraph transmission, it is believed to be the longest coaxial cable yet constructed and the longest polythene insulated submarine cable in existence.

Telegraph terminal and repeater equipment which will enable nine simultaneous teleprinter circuits to be obtained initially is being supplied by Siemens Brothers and Co., Ltd. It is expected that with telegraph repeater equipment at the cable terminals only upwards of fifteen teleprinter circuits will be obtained. At a later date and after investigation of noise levels a submerged repeater will be inserted in the cable and then up to thirty-six teleprinter circuits will be made available.

These circuits will be operated between London and Copenhagen, using British and Danish Governments' land lines. A special tie cable between the Danish landing point at Fanoe and the Danish land line terminal at Esbjerg has also been provided by Siemens Brothers as part of the terminal repeater equipment. This tie cable, which is 6 miles long, carries the "go" and "return" pairs for the telegraph circuits, and in addition carries 50 c/s alternating current to feed the apparatus and special control wires for the remote control and position indication of this apparatus in the unattended Fanoe hut.

The submarine cable is the type which has been used extensively by the British Post Office for Continental telephone traffic since the summer of 1945. The central conductor comprises a single copper wire surrounded by thin copper tapes, the diameter of the combination being 0·17in. This is insulated to a diameter of 0·62in with "Telcothene," a mixture of polyethylene and polyisobutylene specially developed and processed for submarine cable work. An outer conductor comprising six long-lay copper tapes is formed directly on the surface of the dielectric to provide a path of low resistance for the carrier frequencies to be transmitted. The six tapes are held in position by a short-lay copper binding tape, and the core is then served with tarred jute and armoured with twelve No. 2 (0·276in) galvanised iron wires. An outer serving of tarred jute completes the cable, which has an overall diameter of 1·75in and weighs (in air) nearly 10 tons per nautical mile.

For 500 fathoms seaward from each terminal station the outer conductor is insulated, before being served, with Telcothene of radial thickness 0·10in. This insulation enables any extraneous currents which may be induced in the outer conductor near the shore to be controlled and minimised; as an added precaution against interference a lead sheath is applied to the short lengths lying in trenches between low water mark and the cable stations. The number of armouring wires is increased to fourteen in the "insulated outer" portion and to sixteen at the extreme ends where the lead sheath is used.

The laid length of the cable is 306 nautical miles and the electrical characteristics per nautical mile at a temperature of 10 deg. Cent. are as follows:—

D.C. resistance (centre conductor) ...	2·21 ohms
Capacitance	0·185 microfarad
D.C. insulation	2×10^6 megohms
Attenuation at :	
5 kc/s	0·34 decibels
10 kc/s	0·44 decibels
15 kc/s	0·52 decibels
20 kc/s	0·59 decibels

Manufacture of cable and equipment was started twelve months ago. The laying operations just completed were started a month ago by the Great Northern Telegraph Company's cable ship "Edouard Suenson," which then laid the two shore end sections, each 25 nautical miles in length, in readiness for H.M.T.S. "Monarch."

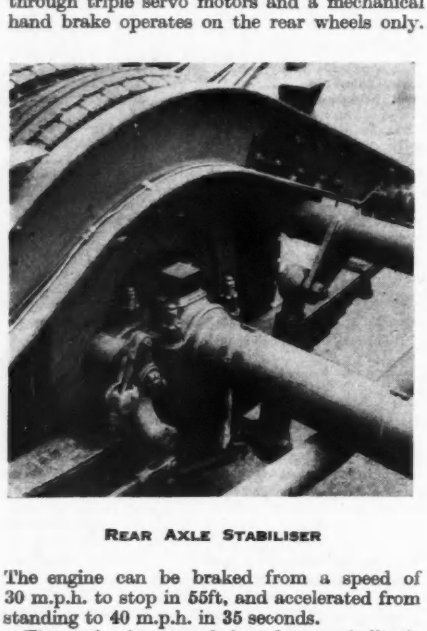
Cement Supplies.—At a recent Press conference, Lord Selborne, chairman of the Cement Makers' Federation, stated that the cement industry was at present manufacturing more cement than ever before. During the first half of 1950, deliveries in the home market were the highest on record, being over 3,900,000 tons, or about 330,000 tons more than in the first half of 1949. The export drive had also been maintained, though exports were slightly lower. The total deliveries, home and export, for the period, exceeded the total for the first six months of last year by over a quarter of a million tons. Lord Selborne said that the industry was pressing on as fast as it was allowed to, and he hoped that its capacity would be materially increased in 1950 and 1951. It was also stated at the conference that of the cement produced for the home market, about one-third goes to housing, 13 per cent to industrial constructions, 10 per cent to national constructions, 10 per cent to merchants' yards (repairs, &c.), 14 per cent to concrete products, and to several other classes of consumers each taking less than 4 per cent.

Diesel-Driven Fire Engine

We illustrate below one of two new diesel-engined fire engines which have been delivered to the Middlesex County Council by Merryweather and Sons, Ltd., of Greenwich, London, S.E.10. Each of these engines is driven by a 6-cylinder A.E.C. oil engine, developing 125 b.h.p. at 1800 r.p.m. The drive is taken through a four-speed gearbox, and a divided propeller shaft fitted with universal joints. The rear axle ratio is 4⁴/₇ to 1, the gears employed being top, direct; third, 1·59 : 1; second, 2·69 : 1; first, 5 : 1; and reverse, 6·43 : 1.

Diesel Fire Engine

A foot brake operates on all four wheels through triple servo motors and a mechanical hand brake operates on the rear wheels only.



Rear Axle Stabiliser

The engine can be braked from a speed of 30 m.p.h. to stop in 55ft, and accelerated from standing to 40 m.p.h. in 35 seconds.

The engine is suspended on four semi-elliptic springs, and has hydraulic dampers fitted to the front axle. In the underslung worm-type rear axle the axle shaft is fully floating. Stabilising gear fitted to the rear springs to prevent undue rolling when the vehicle is cornering does not in any way restrain the normal independent rise and fall of the road wheels. One end of the stabiliser gear bar and the link between it and the off-side rear spring can be seen in one of our illustrations.

The fire pump is driven by a power take-off from main gearbox and is mounted centrally on the vehicle on a special frame. A lifting ring is fitted on the pump unit which, together with its frame, can be lifted through a hatch and removed for inspection or maintenance purposes. The single-stage turbine pump when working on a 10ft suction lift through two 8ft lengths of suction hose delivers from 1000 gallons of water at 80 lb per square inch to 600 gallons at 180 lb per square inch.

This pump has an overhung balanced impeller which can be easily reached for inspection by the removal of the suction end cover. A double-cylinder reciprocating priming pump has horizontally-opposed pistons designed to take full advantage of the high speed of rotation.

A first aid hose reel is mounted on each side of the appliance and a 100-gallon water tank is situated in a readily accessible cross position towards the rear of the vehicle. The rotary first aid pump is driven by an auxiliary power take-off on the side of the gearbox, and has a capacity of 25 gallons per minute at a pressure of 100 lb per square inch.

A 55ft wooden wheeled escape with a sliding carriage is carried on a rear sliding cross bar so that the escape, when in position, can be pushed forward bodily to reduce the overhang. The overall length of the engine, with the escape mounted, is only 26ft.

The vehicle has a limousine-type body which gives comfortable accommodation for the crew and a large locker space. In the forward compartment the driver and officer are well placed to give a clear view of the road and behind this compartment seating is arranged for a crew of four men. In addition to the standard road lights the vehicle carries a searchlight, spot light, fog lamp, and blinker lights.

Castellated Construction.—It may be recalled that in our issue of September 23, 1949, page 352, a description was given of a method of increasing the bending strengths of rolled steel sections, known as "castellated construction," developed by the Appleby-Frodingham Steel Company, Scunthorpe, Lincs. That company has now issued an illustrated brochure describing the method and giving a series of graphs comparing the strengths of British Standard sections and castellated sections made from them. The brochure may be obtained from the construction department of the Appleby-Frodingham Company on application.

D.C. Transmission from the Swedish Mainland to the Island of Gotland*

The Swedish State Power Board recently decided to establish a high-voltage d.c. transmission system at 100kV in order to supply water power to the island of Gotland, situated in the Baltic 100km from the Swedish mainland. The capacity of the plant will be 20,000kW and it is estimated to be ready for use 1954 or 1955.

Experiments with High-Voltage D.C.

Development work for the transmission of power by high-voltage d.c. has been carried on for a long time by the Swedish electrical firm Allmänna Svenska Elektriska Aktiebolaget (A.S.E.A.). In order to have an opportunity for practical experiments co-operation began in 1943 between this company and the State Power Board, with the result that, a joint experimental station was built and commenced operating in 1945. Since then tests have been carried out continuously and have given such promising results that the time is now considered ripe to go on to the next stage in the development of converters for high-power transmission over long distances. A new experimental station for tests using larger valves is under construction and will be completed by the autumn of 1950.

At the same time as the tests were carried out in the experimental station the State Power Board investigated the possibility of establishing d.c. transmission for regular use.

The investigations were regarding a project to transfer water power from the Swedish mainland to the island of Gotland. This project offers special advantages as the transmission must be effected by cable and the required power transmission is in reasonable relation to the size of the rectifiers, which have now been tested at the experimental station. The reasons for this d.c. transmission are: first, to reduce the power costs on the island; secondly, to have an opportunity of studying the practical problems arising from the use of high-voltage d.c., and through the scheme obtain valuable ideas for further development work.

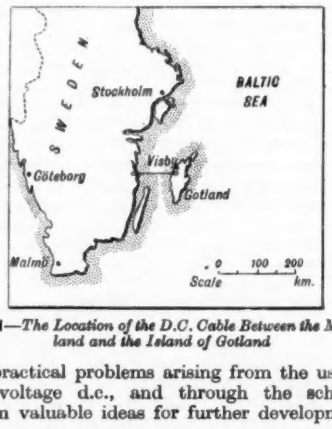


Fig. 1—*The Location of the D.C. Cable Between the Mainland and the Island of Gotland*

As the investigations have shown that the project can be put into practice at a reasonable cost, the Board at the end of 1949 asked for a grant to carry out the scheme.

This proposal will be considered by the Swedish Parliament during the first six months of 1950.

Gotland and its Present Power Supply

The island of Gotland is situated in the Baltic approximately 100km from the Swedish mainland (Fig. 1). The distance between the north and south points of the island is 125km and the maximum width is 50km. The population is 59,000, of which 14,000 are in Visby, the only town on the island. The most important industries consist of a fairly large cement factory and several limestone and marble quarries.

Gotland has no water power of its own and

* C.I.G.R.E. meeting, Paris, June–July, 1950. Paper by Ake Rusck, President, Swedish State Power Board; B. G. Rathsman, chief engineer, Swedish State Power Board; and U. Glimstedt, engineer, A. B. Skandinaviska Elverk (Sweden).

is entirely supplied by local steam plants belonging to A. B. Gotlands Kraftverk, who also undertake the rural distribution. The total power generated after extensions now under way will be approximately 27,000kW, of which 11,000kW are in reserve. The power is distributed at 50 cycles a.c. over a 33kV, 11kV and 6·6kV network.

The total demand on Gotland is at present appromately 11,000kW, but the consumption is increasing rapidly. Nearly 90 per cent of the population have access to power at the present time. It is estimated that the total demand in 1955 will have reached 16,000kW and in 1960 about 18,000kW.

Owing to the power being produced by steam plants, the power costs, due to the present high price of fuel, are considerably higher than on the mainland, where the demand is met by water power. Variations in fuel costs bring with them, moreover, the uncertainty of future power costs. These disadvantages can to a large extent be eliminated when Gotland is linked with the mainland.

Table I—*Transmission Losses and Voltage Drop**

Type of current	Nominal operating kV (voltage received on Gotland)	Transmission losses as percentage of the power supply from the mainland		Voltage drop in the cable as percentage of the transmission voltage from the mainland
		in the cable	total	
A.C., 25 cycles	45	17	37	17
	70	10	20	7
	100	8	28	3
A.C., 16⅔ cycles	45	17	37	17
	70	9	29	7
	100	7	27	2
D.C.	100	2	10	2

* The values given apply to a 100km power transmission between the Swedish mainland and Gotland, with different types of currents and a power transmission of 10,000kW. For the a.c. alternatives a cable area of 2 × 75 square millimetre copper is estimated, while for d.c. a cable area of 75 square millimetres copper is estimated with a return through the sea.

A.C. or D.C.

Owing to the great distance between the mainland and Gotland, approximately 100km, transmission of 50 c/s power cannot be carried out by reasonable means. On the other hand, it would not be impossible to use a.c. with, for example, 25 c/s or 16⅔ c/s transformed from 50 c/s on the mainland, and then transformed back again to 50 c/s on Gotland.

If transforming is to be effected by rotary converters, the losses and voltage drops in the transmission would be many times greater than if the transmission is effected with high-voltage d.c. (Table I). In addition, the costs for the a.c. alternatives would be considerably higher than for those of d.c.

A transmission of power between the Swedish mainland and Gotland must therefore (if it is to be accomplished economically) be effected by high-voltage d.c.

It is obvious that the project is not entirely without obstacles as no previous experience has been gained in operating similar plants, and the transmission of power to Gotland, both with regard to size and method of transmission, will be unique. Certain teething troubles must be expected, but it is considered that it will be possible to overcome them after a time.

High-Voltage D.C. Plant

The plant will include a rectifier station on the mainland, an inverter station on Gotland, and a cable connection which in the first stage of building will consist of only one single core. The current will thus have a return circuit through the sea.

The plant will be constructed for 100kV d.c. to earth. The operating current will have a maximum value of 200A and a transmission capacity, therefore, of 20,000kW. When the load on Gotland eventually exceeds this maximum the cable and converter equipment will be duplicated so that the transmission capacity is increased to 40,000kW. One cable will then be positive and the other negative, and the return circuit through the sea will be abolished.

The power which is to be sent to Gotland is transmitted to the rectifier station on the mainland as 130kV, a.c., 50 c/s (Fig. 2), and is converted in mercury arc rectifiers into direct current at 100kV with a maximum of 200A. One pole of the rectifier station is earthed through an electrode in the sea. The current from the other pole is transmitted to Gotland through the cable; it passes through the inverter station on Gotland and afterwards to an electrode in the sea near the coast. The power from the inverter station is fed into the 30kV, a.c. network on Gotland.

The Converter Stations

The rectifier station on the mainland and the inverter station on Gotland will have approximately the same electrical equipment, which has been projected by A.S.E.A. They will differ mainly with regard to the method of controlling the rectifying valves. The valve side windings of the main transformers will each be connected to a set of six rectifying valves, connected in "six-pulse, double-way" connection, as shown in Fig. 2. Each group of valves will also include a by-pass valve which will start functioning at disturbances in the main valves themselves.

The six main valves included in one set of valves link the d.c. circuit in succession with different paths on the a.c. side, whereby a d.c. voltage of 50kV is generated. By coupling the two groups of valves in series the d.c. voltage is increased to 100kV. The two secondary windings of the converter transformer are 30 deg. out of phase in order that certain harmonics in the 100kV supply may be eliminated. This gives both a more even d.c. voltage and less reaction of harmonics on the a.c. network.

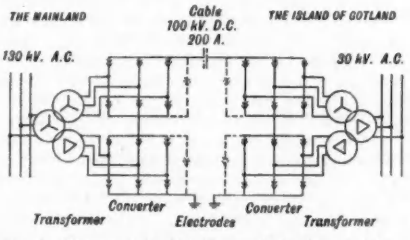


Fig. 2—*Diagram of the D.C. Transmission from the Mainland of Sweden to the Island of Gotland*

During occasional and momentary disturbances in a valve, the whole valve group will be blocked by the quick-acting grid control at the same time as the current is directed through the above-mentioned by-pass valve. The converter station will thus continue to function with half the voltage and power for the duration of the fault. As soon as the cause of the fault has been eliminated, the temporarily disconnected valve group will again start functioning, whereupon the complete operation can be resumed. The disconnection and reconnection takes place so rapidly that the receiving network on Gotland will not normally be affected by the disturbances.

As the inverter station on Gotland can only supply active power to the receiving a.c. network, the reactive power, which is consumed partly by the network on Gotland (approximately 75 per cent of active power received) and partly by the inverter itself (60 to 70 per cent of active power transmitted), is injected locally by synchronous condensers, possibly combined with static condensers. For the first stage of construction a synchronous condenser of approximately 25MVA is necessary.

Cables and Electrodes

The d.c. cable projected by A.S.E.A.'s cable works (A. B. Liljeholmens Kabelfabrik) is likely to be manufactured as a mass impregnated cable with a copper area of 120 square millimetres, and having an oval section so that the water pressure will be transmitted via the lead cover to the insulation. As an alternative, investigations are under way with regard to the possibility of using polyethylene as insulation and to eliminate the lead cover.

The return circuit through the water does not appear to present any special problems. In order to avoid corrosion on the d.c. cable and on a telecable already laid, the electrodes will be placed at a distance of 7km to 10km from the cables. The outgoing transmission to the electrodes will be effected by unarmoured cables. The electrodes themselves will be made of magnetite, which in previous experiments with current transmission through the earth has proved to be a durable material. One question was, whether the current could be injurious to fish and other organisms in the water. For this reason, during the summer of 1949, extensive experiments were carried out transmitting a maximum of 200A, d.c., across a bay on the mainland side. No injurious effects were observed other than in the immediate vicinity of the electrodes (within approximately 2m distance from the electrodes). In order to eliminate completely this risk screens will be placed 20m from and around the electrodes.

Regulating of Voltage and Power

The a.c. voltage on Gotland will be regulated by the voltage control device on the synchronous condenser. The power regulation is planned for two different operations. It is expected that normally the mainland will meet the whole of Gotland's power demand. The d.c. power transmitted will therefore be regulated according to the load variations on Gotland, so that a stable frequency is maintained. Alternatively, it is expected that a constant power can be transmitted from the mainland, while the load variations are equalised by the local power stations on Gotland. There is also a possibility of the plant being built for reversible operation, so that steam power, when required, can be transmitted from Gotland to the mainland.

Costs and Building Programme

The cost of the whole transmission plant, prior to devaluation of the Swedish Crown in the autumn of 1949, was estimated at 9·5 million Swedish Crowns, of which approximately 3·5 million is for the cable.

The price of the water power transmitted to Gotland is estimated with the present high coal prices, to be somewhat lower than that of the locally generated steam power.

In order, however, to accomplish a larger reduction of power costs, it is expected that the Swedish Government will make a grant, free of interest and amortisation to cover the whole cost of the plant. It will, however, be necessary to keep the cost of power on Gotland a little higher than on the mainland in order to maintain the existing steam power plant as a reserve for the d.c. transmission.

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Metallurgical Topics

Embrittlement of Hardened Steel on Tempering at 250 to 400 Deg. Cent.

In the tempering of certain hardened alloy steels, it is necessary, if low impact values are to be avoided, never to make use of tempering temperatures between about 250 deg. and 400 deg. Cent. A typical example of the embrittling effect of temperatures within this range is shown in Fig. 1, taken from the recent work of H. Schrader, H. J. Wiester and H. Siepmann.[1] It is well known that nickel-chromium and nickel-chromium-molybdenum steels show this effect, whereas fully hardened nickel steel does not show appreciable embrittlement when tempered in this range, an observation confirmed by these authors. With a manganese-chromium steel containing carbon 0·2, manganese 1·5, chromium 1·5 per cent, as a basis, a study has been made by Schrader, Wiester and Siepmann of the influence, on impact figure and hardness, of rate of cooling in hardening, temperature and time of tempering, and rate of cooling after tempering.

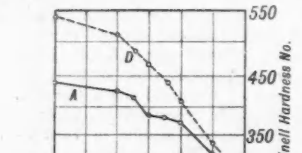

FIG. 1—*Embrittlement on Tempering of Steels Water-Quenched from 830 deg. Cent. and Cooled in Water After Tempering for Two Hours*

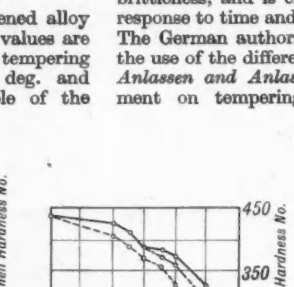

FIG. 2—*Embrittlement on Tempering at 300–350 deg. Cent. Effect of Time of Tempering. (The Low Impact Values After Long Tempering at 400–500 deg. Cent. are Due to Temper-Brittleness.)*

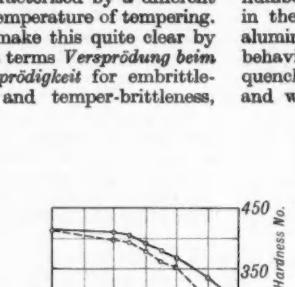

FIG. 3—*Effect of Adding Molybdenum and of Increasing Time of Tempering of the Manganese-Chromium-Molybdenum Steel*

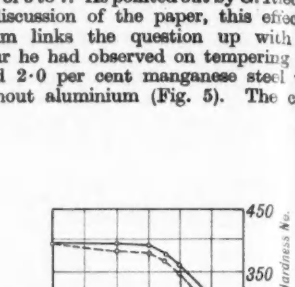

FIG. 4—*Effect of Aluminium in Eliminating the Embrittlement (Schrader, Wiester and Siepmann)*

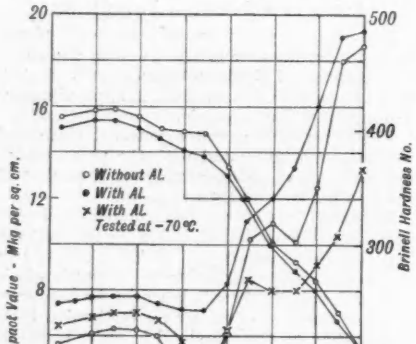

FIG. 5—*Influence of 0·3 per cent of Aluminium on the Embrittlement on Tempering of 0·18 per cent Carbon, 2·0 per cent Manganese Electric Furnace Steel, Water-Quenched from 840 deg. Cent. (Riedrich)*

It may be desirable to emphasise at the outset that this embrittlement is distinct from temper-brittleness, and is characterised by a different response to time and temperature of tempering. The German authors make this quite clear by the use of the different terms *Versprödung beim Anlassen and Anlassprödigkeit* for embrittlement on tempering and temper-brittleness, though this important distinction is not always preserved in translation or in reference to the subject in English.

Fairly severe quenching is necessary to produce the embrittling effect of tempering in this range. The effect was still shown by the manganese-chromium steel after air cooling from 830 deg. Cent., but after furnace cooling or heating below A_3 there was no embrittlement on tempering at 250 deg. to 400 deg. Cent. After water quenching and tempering for two hours at 350 deg. Cent. the notched-bar impact value of this steel fell to 2mkg per square centimetre. When the tempering was prolonged the same minimum impact value was reached at a lower tempering temperature, and after an improvement at 350 deg. to 400 deg. the temper brittleness effect became apparent after tempering at 400 deg. for 500 hours or at 500 deg. for ten hours. This is shown in Fig. 2. The development of temper-brittleness is too slow to be noticeable in ten hours at 400 deg. Cent., but tempering at 500 deg. Cent. produces the same low impact figure in ten hours as in 500. Slow cooling after tempering the water-quenched steel gave nearly the same impact figure as rapid cooling for all tempering temperatures up to about 500 deg. Cent., but after tempering at 600 deg. Cent. the impact figure of the quickly cooled specimen was nearly double that of the specimen cooled at 0·5 deg. Cent. per minute.

Steels of higher carbon content show the same effect of tempering at 250 deg. to 400 deg. Cent., but the trough of low impact values apparent in the curve (for example, steel *D* in Fig. 1) is not so obvious, as the initial value of the impact figure becomes lower as the carbon content increases. The addition of 0·5 per cent of molybdenum had no effect in eliminating embrittlement on tempering at 250 deg. to 400 deg. Cent. (Fig. 3), though it, of course, minimises susceptibility to temper-brittleness in this manganese-chromium steel; but the addition of aluminium had a pronounced effect (Fig. 4). An aluminium content of 0·04 per cent greatly reduced the embrittlement and 0·1 per cent practically eliminated it. This was not a question of grain size as nearly all the steels were fine grained with McQuaid-Ehn numbers of 6 to 7. As pointed out by G. Riedrich in the discussion of the paper, this effect of aluminium links the question up with the behaviour he had observed on tempering of a quenched 2·0 per cent manganese steel with and without aluminium (Fig. 5). The cause of the embrittlement was not completely removed even by 0·3 per cent of aluminium, as the minimum after tempering at 350 deg. Cent. appeared again very clearly in the impact value curve of specimens broken at −70 deg. Cent.

Embrittlement on tempering at 250 deg. to 400 deg. Cent. was attributed by the authors to precipitation, from the supersaturated α solid solution, of chromium or manganese nitrides in the most effective degree of dispersion. The addition of aluminium was held to produce aluminium nitride which is insoluble in the solid solution and therefore cannot lead to precipitation. They supported this explanation be referring to the work of C. Holthaus and W. Holtmann[2] (and other investigators), who found that the nitrides present in quenched low-chromium steel were soluble in hydrochloric acid whereas in steels which had been tempered at above 400 deg. Cent. increasing amounts of undissolved nitrides remained in the residue. Holthaus and Holtmann also found that in the presence of sufficient aluminium all the nitrogen was in the form of aluminium nitride which was soluble in either acid or caustic soda. Moreover, according to O. Meyer and R. Hobrock,[3] aluminium nitride is insoluble in steel up to a high temperature and therefore, as no solution is formed, cannot be precipitated by tempering after quenching. Observations of the effect of aluminium, in the opinion of the authors, render their previous explanation—that the embrittlement was due to a critical dispersion of precipitated carbide in martensite—untenable. They admit that the truth of their assumption that nitrides are precipitated is not fully demonstrated, but regard the explanation as a useful working hypothesis. The final explanation must await further investigation. From the practical point of view the important point is their claim that the embrittlement can be done away with by the addition of aluminium.

[1] *Archiv für das Eisenhüttenwesen*, 1950, Vol. 21, page 21.
[2] *Ibid.*, 1943–44, Vol. 17, page 247.
[3] *Ibid.*, 1931–32, Vol. 5, page 251.

Russian Work on High Temperature Hardness Tests

I. L. MIRKIN, *et al.*,[1] have reported on work recently undertaken at the All-Union Inst. of Aviation Materials on high temperature hardness of alloys and its correlation with other properties. Hitherto the study of heat resistance of alloys at high temperatures has involved much expenditure of time and material and the need was felt in Russia to evolve a more speedy and cheaper method. It was claimed that this could best be achieved through hardness tests up to about 800 deg. Cent., and these should prove the more valuable as it has long been recognised that hardness is a fairly safe guide to other properties. The present workers, indeed, confirm that such correlation is still more valid at the higher temperatures used in this work, as suggested earlier by Bochvar,[2] although he did not go beyond 300 deg. Cent. in his experiments with light alloys. Other previous workers had used a cold indentor on hot test pieces, but this is not considered satisfactory or reliable, owing to cooling of test piece. As practised hitherto, with the ordinary Brinell machine, it was not possible, without considerable trouble, to go much above 500 deg. Cent., and the suggested use of vacuum or protective atmospheres to avoid oxidation or damage to the diamond or Pobedite indentor was certainly added labour and complexity.[3]

Mirkin and his co-workers have also used the Brinell apparatus with a metallo-ceramic (ceramet) indentor, as previously briefly noted in work on the "Mechanical Properties of Metals," by Ya. B. Fridman, 1946. It was considered that, at the temperatures employed, it was hardly necessary to protect the test piece from oxidation, but the indentor was treated with a special chemico-thermal diffusion process whereby it was coated with a protective film. This was stable enough to permit continued use of a 5mm diameter ball under load of 750kg. The apparatus used comprised essentially Brinell testing equipment, surrounded by an electrical tubular furnace of ordinary type, with thermo-couples, &c., for temperatures up to 900 deg. Cent. The shrinkage of the test piece on cooling, and consequent reduction in size of impression, was considered unimportant: with an impression of 2mm diameter, the effect of cooling from 800 deg. to 20 deg. Cent. would be to reduce it by only 0·02mm. The size of the test piece was 15mm by 15mm by 10mm and the load (held for thirty seconds) was 750kg, except for alloys with a hardness range at high temperatures above 300 H_B, when the load was only 250kg. The life of the indentor was thereby prolonged.

Experiments were first made with the basic component metals of the alloys, namely, tungsten, molybdenum, chromium, cobalt, nickel, iron, and their hardness in the temperature range 20 deg. to 800 deg. Cent. determined. Alloys of the first two are made by powder metallurgy methods (sintering, &c.), whilst those based on the other four are cast. Of these latter the chromium alloys, as already well-known, had by far the highest hardness values both at 20 deg. and 800 deg. Cent. (470 H_B and 330 H_B respectively), whilst much lower down in order of declining hardness were alloys based on cobalt, nickel, iron. Curves of declining hardness with rising temperature were not, of course, uniform or parallel with these four classes of alloys; in other words, the differences between them at 20 deg. Cent. were not the same as those at 800 deg. Cent.

In connection with their "hot-hardness" tests the authors point out that they observed quite a number of new factors, including the effect of modifying alloy elements (not specified), and that their results are still more interesting when compared with the time factor in tests to destruction or collapse of a test piece under constant load. In 100-hour tests at 700 deg, 800 deg. and 900 deg. Cent., under loads up to 30kg per square millimetre the chromium alloys gave much the best results at 900 deg., with the load at 20kg per square millimetre. Reference is made to the unspecified "alloying elements" with somewhat irritating frequency; in one case with solid solutions of Ni-Cr-Fe and alloys prepared therefrom with these mysterious additions, hardness was increased from two to four times—according also to ageing treatment. Moreover, hardness tests at 20 deg. Cent. only might lead to the erroneous conclusion that these alloying additions had little or no effect, since hardness at that temperature is practically the same after ageing at 600 deg. and 700 deg. Cent., and differs by only about 15 per cent. after ageing at 800 deg. Cent. But "hot-hardness" tests give quite other results: an alloy after modification with suitable "alloying elements," showed, at 800 deg. Cent., hardness 50 per cent higher than one without these additions.

Special importance is attached to the correlation of "hot-hardness" with other properties, e.g., long-term heat-resistance or stability. It is considered in detail in regard to a high-nickel alloy. The curve relating hardness and stability in hours is practically linear, but hot-hardness cannot always strictly and definitely determine long-term stability (heat-resistance) for this reason—a hardness test actually measures mainly the resistance of a metal to plastic deformation under "soft" conditions of load, and represents the most important factor on which depends metal stability. It is therefore natural that there should be some relation between hardness and stability. But in studying long-term stability there are naturally other factors not necessarily represented in hardness tests, hot or cold. One of these is said to be, by way of example, some earlier or previous form of plastic deformation in test piece that may hasten its collapse under test; in which case there can be no proper correlation between hardness and stability. Apart from this, it was found generally, in the present work, that with hot hardness below 180 H_B stability was less than 35 hours, and with hardness values above 200 H_B it was more than 60 hours.

Another point discussed is the relation between hardness variation and time factor in load application. A. A. Bochvar[2] had stated that the extent of decrease in hardness in a given time interval and the final hardness value should give some indication of creep under the given temperature conditions. In prolonged tests under constant load there should be reduced stress owing to gradual increase in diameter of impression, and thus also a gradual slowing-up in hardness decline—according to type of metal or alloy. In course of time there is change in the ratio of diameters of ball and impression. The present authors for the most part had impressions of 2mm to 3mm for an indentor of 5mm diameter, or a ratio of 0·4 to 0·6.

They describe finally their "three-short-hot" hardness test method, comprising three tests, of which first was thirty seconds, the second five minutes, and the third fifty minutes. They do not consider longer periods necessary. Examples, with diagrams, are also given to show that the relative position of alloys in the "hot-hardness" scale may be reversed in cold tests.

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[1] *Zavodskaya Lab.*, 1949, No. 9, pages 1080–1087.
[2] *Bulletin*, Acad. Sci., U.S.S.R., Tech. Sci. Section, 1947, No. 10.
[3] F. P. Bens, Trans., Am. Soc. for Metals, 1937, Vol. 38, page 505.

Metallurgical Exhibition

AMONGST the activities of the Science Museum, South Kensington, is the arrangement of special exhibitions illustrating some feature of scientific or technical activity of current interest. The scope of the exhibition "Metals in the Service of Mankind," now on view there, has already been indicated in THE ENGINEER for July 7th. Trade and Research Associations and many individual firms have co-operated in organising the exhibition and in providing exhibits which illustrate not only the varied uses of metals and alloys, but also in some instances, modern practice in extraction and refining, as well as in powder metallurgy, electrodeposition and surface protection. The Exhibition is of special interest to engineers and metallurgists as it illustrates so well the interdependence of their work, and assembles such a wide range of examples of engineering achievement based on the development of suitable metallurgical material.

The Handbook of the Exhibition[1], issued jointly by the Institution of Metallurgists and the Science Museum, presents in a simple manner, the story of the discovery, development, properties and uses of the common metals, the precious metals and many of the rarer metals. Its title invites comparison with another book intended for, and appreciated by, the general reader, viz., Street and Alexander's well-known "Pelican"—"Metals in the Service of Man," though it does not attain to the same level as that book in breadth of treatment or in the presentation of concise quantitative information about the properties of metallic materials. The Exhibition Handbook, however, is intended mainly to interest and instruct the casual reader, and especially young people; and the anonymous authors of the eleven chapters are to be congratulated on having presented an outline of the subject which accurately unfolds "the story of the metals" in non-technical language and in a manner that is likely to retain the interest of any visitor to the exhibition.

[1] "Metals in the Service of Mankind." London: The Institution of Metallurgists, 4, Grosvenor Gardens, S.W.1. 1950. Price 1s. net.

Molybdenum Ingots

THE production of molybdenum in the form of cast ingots has been under investigation by the Climax Molybdenum Company since 1943. Before 1946, R. M. Parke and J. L. Ham* were successful in remelting and casting molybdenum powder, either loose or in the form of sintered bars, by a low-voltage electric arc *in vacuo* within a copper mould. By that date ingots weighing 25 lb were being produced, but larger ingots have since been successfully cast. Now, the Climax Molybdenum Company announces the construction of a vacuum arc furnace for the experimental production of ingots of molybdenum and of certain molybdenum-base alloys as large as 9in in diameter and 1000 lb in weight.†

The potential applications of molybdenum, mainly as a heat-resisting material, have been investigated on a fairly large scale by the use of massive blocks of molybdenum, made by powder metallurgy technique, as well as of cast ingots; and forging, rolling, machining and grinding have been successfully carried out. The outstanding problem in the way of extensive application of molybdenum is the necessity for protecting it from oxidation.

The Climax Molybdenum Company emphasises that the 1000 lb furnace is purely experimental, but the scope of possible application of molybdenum would undoubtedly be widened if it proved practicable to produce ingots of this size.

The Fracture of Metals. London: The Institution of Metallurgists, 4, Grosvenor Gardens, S.W.1. Price 12s. 6d.—This publication contains the text of six lectures given in September, 1949, at a refresher course arranged for members of the Institution of Metallurgists. The general subject of "Cohesion and Rupture in Metals" was discussed by Dr. N. P. Allen; fracture in creep, under fatigue and under stress-corrosion conditions was dealt with by Dr. R. W. Bailey, Mr. H. L. Cox and Dr. U. R. Evans, respectively; Dr. C. Gurney described the effect of rate of loading on fracture, and Mr. W. Barr gave an account of brittle fracture in mild steel and the precautionary measures which may be taken to improve its notch ductility at low temperatures. The lectures take the form of critical summaries of existing knowledge, amplified in some cases by references to work not previously published, and thus constitute an up-to-date presentation of various aspects of the subject.

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* *Metals Technology*, September, 1946.
† *Iron Age*, March 30th, 1950, page 117.

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NOTICE TO READERS

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JET AIRLINERS

IN May last an important conference on the problems of jet-propelled airliners was held in New Jersey. The list of those taking part included the major air line interests of the world and the resulting discussion left no doubt as to the wide extent of the new problems involved in the effort to lessen the drawbacks of jet propulsion and to increase the advantages it undoubtedly offers. In addition to the high speed of operation which it invites, other attractive features are the comforting freedom from vibration, a lower engine weight accompanied by easier maintenance, and the use of a less costly and less dangerous fuel than petrol. On the other side of the ledger must be entered the lower thermal efficiency of the engine, the greater complexity of de-icing, particularly when axial flow compressors are used, the high rate of fuel consumption whilst waiting to land at its destination, and the destructive effect of a hot exhaust blast on airport runways. The conference considered also certain of the problems inherent in operations at very high air speeds, including some which are common to airscrew propulsion, by either piston engines or turbines, and not special to jet types. The experience and advice made available by the many speakers who took part concentrated, naturally enough, less on the advantages presented than on suggestions for overcoming difficulties. It seemed to be generally agreed that the present high rate of specific fuel consumption could best be remedied by increasing the thermal efficiency through a gradual increase of operating temperatures to a substantially higher level. The further metallurgical research now being undertaken is, however, certain to take time. The inordinate wastage of fuel because of landing delays—the familiar "stacking" problem—can only be overcome by a change in airways organisation. But this is no easy problem to solve. For it has to meet the awkward question how far the operators of non-jet types of aircraft, queued up at some prescribed stacking level, will be disposed to wait patiently whilst jet aircraft are encouraged to come in freely as soon as they reach the airport.

To obtain reasonably economic results with jet propulsion requires the steady maintenance during flight of very high altitudes, and this factor causes those concerned to take a vivid interest in the meteorological characteristics of the upper region of the atmosphere—especially the 30,000ft to 40,000ft level. Lower down the greater prevalence of clouds makes it easy to recognise areas of high turbulence, whereas at the higher levels the newly discovered "jet air streams" and what are known as "clear air gusts" may be suddenly encountered without warning; enquiry is proceeding, but the conditions in which they occur are at present little known. Research flights made by British European Airways have shown that clear air gusts may move at as much as 200 m.p.h., and be 1000 miles long. But they usually have a "core" of no more than 100 miles or so in length. Some may be dangerous to fly through and all are uncomfortable. Flying through them may do no more than resemble the hammering of a motor boat in a choppy sea, but it is usually wise to bring the effect to an end by a quick change of altitude. The high flying conditions which call for cabin pressurisation, and the possible consequences of any failure in the maintenance of this pressure, were also included in the many topics discussed by the conference. It was thought that a really serious loss of pressure would prove to be very rare, but that if and when such failure did occur the passengers affected might retain consciousness for as much as a minute—not very long perhaps for the taking of any remedial measures which might be possible, but conceivably as long as those concerned would desire.

It was agreed to be almost impossible to design piston and jet engines to be interchangeable in any given air frame; and would probably prove an uneconomical procedure even if it could be adopted. Jet types must be designed to take full advantage of their capacity for easy maintenance and with that nothing should be allowed to interfere. It was this useful feature, maybe, which encouraged some airways operators to aim at as high a daily operation as fourteen to sixteen hours on some of their services. Since this rate of use is equivalent to well over 5000 hours a year, and thus almost double what is at present looked on as good performance, it will be admitted that some of those attending the conference proved willing to set their ambitions at a very high level.

CENTRALISED TRAFFIC CONTROL ON DOUBLE LINES

THE principle of coded remote control signalling, known generally as centralised traffic control, or C.T.C., has hitherto found its most spectacular uses in the signalling of long stretches of single line—mostly in America, but now including some notable stretches of the North Island main line on the New Zealand Railways. It is now not uncommon to find a stretch of 150 miles with trains running to signal indications alone, and yet under the unified control of a single operator working from a remote control panel at some key point on the section. The improvements in running effected by the substitution of C.T.C. for the old practice of written train orders, once so prevalent in America, has been no less spectacular than the new electrical control system by which it has been achieved. In studying such developments one looks naturally to British practice to see whether any possibilities of similar improvements exist here, and, generally speaking, the idea of C.T.C. is dismissed, owing to the density of traffic, the relative shortness of through run with freight trains, and the number of control and indication codes that would have to be transmitted, which at times of pressure might easily prove more than could be handled on the two-wire or three-wire control lines of C.T.C. A recent installation on the Chicago and North-Western Railroad is on this account of great interest, in that a 75-mile stretch of double line has been equipped with C.T.C. and put under the control of a single man on each shift. By British standards it is not a heavily worked route, but there are some features worthy of close attention.

The section recently equipped forms part of the 488-mile main line from Chicago to Omaha, Nebraska, of which the first 30 miles westward from Chicago, include three or more main tracks. Double line begins at West Chicago, and over the succeeding 75 miles, to Nelson, traffic is relatively heavy. Previously the entire double-line section from West Chicago to Omaha had been operated entirely by timetable and train orders, and the switches at intermediate stations and crossing loops had been thrown by hand, when required. This 75-mile stretch between West Chicago and Nelson is now operated by C.T.C. Although the line is used by only twenty-two through passenger trains—twelve eastbound, ten westbound—and sixteen through freight trains in the day, together with seven suburban trains in each direction over the 8½ miles between West Chicago and Geneva, the trains run in groups. Of the ten westbound passenger trains, eight leave Chicago between 5.5 p.m. and 8.10 p.m. in the evening, when there is practically nothing in the way of eastbound traffic. To deal with this service characteristic, and to permit freight trains getting under way during the passenger "rush" periods, both lines throughout the 75-mile stretch have been signalled for either direction of running. Cross-over facilities are provided at intervals not ex-

ceeding 8½ miles apart, and, as an example, freight trains can therefore proceed westward while the evening cavalcade of passenger trains is in full swing, instead of being held in the yard at West Chicago or at an intermediate loop for hours on end. With the complete "line position" displayed before him on the illuminated track diagram of the C.T.C. control machine the train dispatcher, in Chicago, can so order running movements by signal indication, as to make the most use of his track capacity to keep all trains on the move. The C.T.C. territory is divided into two sections: 26 miles, from West Chicago to De Kalb, and the remaining stretch from De Kalb to Nelson. Over the first 26 miles, where between Geneva and West Chicago line occupation is heavier by seven trains in each direction, due to morning and evening suburban traffic, control and indication of signalling apparatus is by direct d.c. codes on the two-wire circuit. Carrier codes for control and indication of signalling functions west of De Kalb are superimposed on the line wires between West Chicago and De Kalb. Thus codes relating to signalling east and west of De Kalb can be transmitted simultaneously, thereby increasing the capacity of the installation for handling traffic movements.

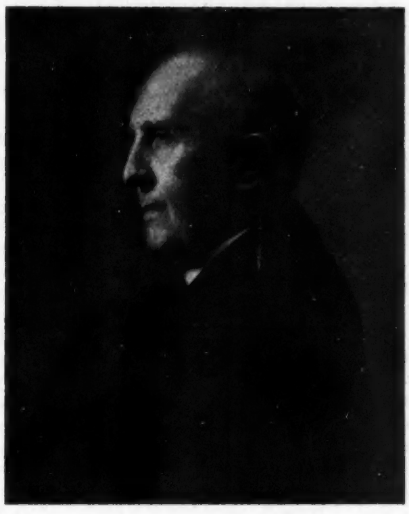
It does not need any very great stretch of the imagination to appreciate something of the vast improvement in freight train operating that has resulted from this particular introduction of C.T.C. in substitution for working by train orders. A patch of colour is added by the story of the local storekeeper at Nachusa losing a market for ninety dozen eggs each week, purchased previously by freight train crews while standing in the loop there awaiting line clear! While conditions are not generally comparable, the slow-moving freight train with its long waits in lie-by sidings and running loops, is one of the greatest problems of British railway operation. Modern methods of traffic control, with the collation of up-to-the-minute information upon loading, locomotive and crew workings, and the constant review of line position, have worked wonders towards the orderly regulation of movement and the avoidance of congestion in terminals, yards and on the line itself; but one cannot study freight train working without becoming impressed with the high proportion of unproductive time and its natural outcome—the slow average speed of trains. In examining details of an installation like that of the Chicago and North-Western one is forced to question whether some improvement in freight train running times might not be achieved by similar means in this country, with consequent reductions in the wages bill, and consequently increased availability of locomotives. The problem is, we agree, a highly complex one, and we are not suggesting that the present time is an opportune one for embarking on schemes involving high capital expenditure. It is a matter of history on the British railways, however, that periods of retrenchment have proved merely the prelude to striking traffic and engineering developments, and the experience of our American cousins in their attempts to alleviate freight train congestion may well include some pointers towards the improvement of working on our own crowded tracks.

Obituary

DAVID E. ROBERTS

THROUGHOUT his long professional career, Mr. David Roberts took a prominent part in the work of the engineering and iron and steel industries, particularly in South Wales. His many friends there and in other parts of the country will learn with deep regret of his death, which occurred at St. David's Hospital, Cardiff, on July 21st, at the advanced age of eighty-three.

David Evan Roberts was born at Merthyr Tydfil, where his father, the late Evan Roberts, was for many years manager of the old Plymouth Ironworks. He was educated at a private school and at Christ College, Brecon, and in October, 1883, began an apprenticeship in the engineering department of the Rhymney Iron Company. After gaining experience in the shops, Mr. Roberts spent two and a half years in the drawing office, during the latter part of which he was the Rhymney Company's head draughtsman. It is of special interest to note, in recalling the importance which he placed throughout his career upon sound technical education, that during his five years with the Rhymney Company, David Roberts attended technical evening classes



DAVID E. ROBERTS

arranged by University College, Cardiff. After leaving Rhymney, Mr. Roberts entered the service of the Dowlais Iron Company, and in March, 1891, he was appointed assistant engineer of the steelmaking department. Six years later he was promoted to the position of engineer of that department. In March, 1902, he became chief engineer of the Dowlais Iron Company and under his guidance several extensions to the various sections of that company's works were successfully completed.

By far the greater part of Mr. Roberts' working life, however, was spent in private practice as a consultant. He dealt primarily with matters related to iron and steel production, his business taking him to many parts of the world. Prior to the first World War he regularly visited the U.S.A. and after that war he represented several American financial organisations in connection with loans to various European countries. During the first World War, Mr. Roberts became attached to the iron and steel department of the Ministry of Munitions and was closely concerned with the majority of the iron and steelworks extensions which then had to be carried out. He also assisted in the control of the national shell factory at Cardiff.

Mr. Roberts was elected to membership of both the Institution of Civil Engineers and the Institution of Mechanical Engineers in 1903. To the latter Institution especially, he rendered distinguished service. His first contribution to the "Mechanicals" Proceedings was a paper on "The Development of Blast Furnace Blowing Engines," which was presented at the Institution's summer meeting in Cardiff in 1906. The next occasion of a "Mechanicals" summer meeting in Cardiff was in 1938, the year in which Mr. Roberts was President of the Institution. His presidential address, delivered in October, 1938, was an excellent survey of the many developments in iron and steelworks which he had witnessed, and in which he had taken part, during his more than forty years' experience as a mechanical engineer.

Another society, which Mr. Roberts joined in 1903—and one with the progress of which he was closely associated—was the South Wales Institute of Engineers. He served that Institute as President in 1922, and five years later was elected one of its few honorary members. There were many other calls upon Mr. Roberts' experience and ability, among them being the chairmanship of a committee set up by the Commissioner for Special Areas to investigate the possibilities of oil-from-coal processes. He was a Freeman of the City of London and a Liveryman of the Worshipful Company of Blacksmiths, of which he was to have been made Prime Master this week. Mr. Roberts also took an active share in the work of the National Museum of Wales, serving on its Court of Governors, and having acted, for the last ten years, as treasurer, an office which he said kept him in touch with many matters of current interest. For his recreation, Mr. Roberts enjoyed golf. He had been a member of the Royal Porthcawl Golf Club since 1906.

David Roberts will always be remembered by his contemporaries with affection. He was one of those happy men who have the qualities that make for friendship and none of those that provoke animosity. Kindliness and good feeling emanated from him and drew to him even passing acquaintances. His presidency of the Institution of Mechanical Engineers was as remarkable for the warmth of feeling that he inspired on social occasions, as at the Summer Meeting in Cardiff in 1938, as for the harmony with which he conducted the business of the Institution during his year of office. Although an old man at the time, so that some feared the strain of office might overtax him, he never flinched for an instant, but was constant throughout in his duties. One of the oldest of surviving members of Council of the Institution, his passing widens the ever increasing gap between the Institution as it was, a relatively small organisation, and the Institution as it is to-day, with a greatly extended field of operations. The members of to-day hardly knew him but he will live in the hearts of those who for many years worked by his side.

SIR HARRY GILPIN

WE regret to have to record the death of Sir Harry (Edmund Henry) Gilpin, which occurred suddenly in London, on Monday last, July 24th. He was a director of Baker Perkins, Ltd., Peterborough.

Edmund Henry Gilpin was born in 1876 and was educated at the Friends' School, Ackworth. He became a director of Baker

Perkins, Ltd., in 1912, and in addition to his activities as an industrialist, he was keenly interested in politics. From 1943 to 1946 he was chairman of the Liberal Party. He was appointed to the Board of Trade's advisory council on export credits in 1931, and in 1946 became chairman of the Industrial Co-partnership Association. He was created a knight last year.

Among Sir Harry Gilpin's many services to industry was the leadership of the United Kingdom engineering mission to Canada in 1948. That mission, it will be recalled, was appointed to investigate market possibilities in Canada, mainly for heavier types of industrial engineering equipment, and to advise on the most suitable methods for securing a greater volume of exports from this country. Sir Harry's experience of Canadian industry was of tremendous assistance to the work of this mission. The adoption of recommendations made in its subsequent report has undoubtedly contributed in no small measure to the improvement in British engineering exports to Canada, which has occurred during the past year.

Literature

Through Five Generations: The History of the Butterley Company. By R. H. MOTTRAM and COLIN COOTE. London: Faber & Faber, Ltd. Price 12s. 6d.

VERY often volumes that are brought out to celebrate the jubilee, the centenary, the bi-centenary or some other event in the life of a firm make very dry reading. They become, in fact, of real and permanent interest only to those who work or have worked in the firms concerned, to people, that is, who can clothe the catalogue of men, events and products provided by the author with flesh-and-blood memory of human activity and a recollection of the personal characters, at least of some of those whose actions have ruled the destinies of the firm concerned; to people, that is, aware of the traditions that gather strongly around any long-lived organisation giving it, as a whole, despite the constantly changing human units of which it is composed, an individual and particular character.

Ostensibly, the authors of the volume that lies before us have written just such a history of the Butterley Company up to the time when its coal-mining assets were handed over in excellent working and profitable order to the National Coal Board. But though, indeed, that may at the start have been their intention, they have, in fact, been inspired to a wider conception of their task. Their book is not merely a history of the Butterley Company. It is, in reality, a social history of coal-mining communities in this country over the last two centuries and more, illustrated in particular by the experiences of the Butterley Company. So much, indeed, is this a social history rather than the mere limited history of an individual company, that in reading the book the particular date at which the Butterley Company was started made no special impression on our minds, and we found it necessary, before writing this review, to make a search through the pages to find it. It is indicative of the way history flows through the book, that it is not until page 39 is reached that we find a clear statement of the date. "In accordance with the spirit of the age, four men joined together in the year 1790 to establish an ironworks and to exploit the ancient coal workings in the Butterley Hall estate."

Since the war and since it was nationalised, the coal-mining industry has been a constant subject for discussion. Managements and men have both come in for criticism. But the factors that influence present events—the methods of working and methods of payment, the equipment available, lay-out and organisation and, above all, the psychology of the collier—are all of them rooted in the activities of those who controlled and worked in the industry in the past. Here, in these pages, are two men's conception of what did happen in the past. We may not wholly agree with it. Indeed, it is a particular merit of the book that it is provocative of thought. But the general picture of the reactions upon the inhabitants of these islands of the change, for instance, from an essentially agricultural to an industrial community is well brought out. For ourselves, we would not give so much weight, as do the authors, to the intensification of Enclosures in bringing about a deep fall in general living standards between 1760 and the early nineteenth century. Certainly it affected the agricultural population. But the invention of the steam engine, and more particularly its improvement by Watt, had put in the hands of men the power so to increase the productivity of the country that industrially standards of living might well have risen, despite the effect of Enclosures. In our view what held them, temporarily, down was the tremendous effort exerted by men excited and inspired by the apparently limitless possibilities opening before them, to build up the capital equipment of the country. As we know to our cost to-day the diversion of human resources to the creation of capital equipment, however much it may promise to raise standards in the future depresses them in the present. Nor can we agree that in the early nineteenth century "men were considered like matter and considered not to matter except as items in bills of costs." The history of the Butterley Company, as revealed in this book, and that of many another company shows how widespread amongst employers was a paternal benevolence to their workpeople, badly though some employers may have treated them. Indeed, we think the book makes it clear that the authors themselves would not accept the literal truth of the sentence we have quoted. Nor was the belief "God bless the squire and his relations, and keep us all in our proper stations," so commonly accepted in industrial areas as the authors would have us believe. Much of the hardness of the times upon the poor arose, we suggest out of a belief that "self-help" could raise any man to the status of an employer providing only he worked hard enough. It took nearly a century for the appreciation to become general that it is not necessarily a man's own fault, nor is it engrained laziness, that he cannot find any work to do! Moreover, looking back from a more developed age, we criticise with horror such things as the employment of young children and the very long working hours, not realising that for long before the days of the Industrial Revolution, these things had been accepted as an ordinary and necessary part of life. The times were undoubtedly hard. But it is unfair to judge them by present standards.

But we could indefinitely go on discussing this book. For every chapter inspires thoughts either reinforcing those of the authors or tending towards a rebuttal of their opinions. We will make only one further comment in the belief that the authors will feel it desirable to make a correction in future editions. On page 39, the sentence occurs "Savery actually made a steam pump in 1696 and Stephenson over a century later really had no need to watch a boiling kettle in order to conceive the power of steam." That untruthful legend of the kettle applies not to Stephenson but to Watt; and would it not be more appropriate to refer to Newcomen rather than Savery, since it was the former who was the first inventor of a really practicable steam engine?

We have to thank the authors for a very readable and interesting book which many others, lay as well as technical, will read with an enjoyment just as great as ours. We have referred in this review only to the contents of some half-dozen pages of the book. It may be imagined at what length we might have written had we discussed all there is in it that merits discussion!

Applied Thermodynamics Problems for Engineers. By W. J. PECK and A. J. RICHMOND. London: Edward Arnold and Company. Price 21s.

THIS book of worked examples in applied thermodynamics is clearly the work of experienced teachers in the subject. The worked problems have been selected from the past examination papers of the main British and Commonwealth Universities, from the associate membership examinations of the senior Institutions, and from the Whitworth scholarship examinations. The book is divided into twenty well defined chapters. The first is a concise review of fundamental material, including the laws of gases and vapours. The remaining chapters cover the main material of a university degree course, the associate membership examinations, Higher National Certificates, and examinations for Whitworth and Senior Whitworth scholarships.

Each chapter consists of a series of fully worked examples wisely selected to emphasise the main points of the section under consideration. An important merit of the book is in the clearness with which the solutions are set out. The student is encouraged to solve the problems in a series of logical stages, and to present his work in a similarly logical manner. Additional examples for solution by the student are given at the end of each chapter. In all cases the numerical answers are given in stages, again emphasising the separate steps in the solution and enabling the student to check his work as it proceeds. Where appropriate, additional guiding notes to the problems are given. Most chapters are prefaced by a brief introductory section, summarising, without detailed proof, the theoretical work upon which the subsequent solutions depend.

The work will perhaps be of greatest value to the student preparing by private study for an examination. It should, however, find wide use among regular university and technical college students. It is hoped that the possession of this book, giving in readily available form master solutions to so many past examination questions will encourage the serious student to study the more fundamental standard works on the subject. In the past many students have hesitated to use the works of, for example, Ewing, Schmidt or Keenan because of their lack of worked examination-type questions. The present volume forms a useful supplement, in that it presents all the examination questions any student could wish to study and thus leaves him a free choice of book for his study of fundamental principles. The authors have made a useful addition to the

growing literature of Applied Thermodynamics. The book is well printed and very clearly illustrated.

An Introduction to Distribution Methods of Structural Analysis. By R. W. Steed. London: Sir Isaac Pitman and Sons, Ltd. Price 12s. 6d.

During the last twenty years the moment distribution method of rigid frame analysis has been re-expounded many times. In this book of 116 pages, which is not intended to cover any new ground, Mr. Steed has aimed at presenting the method in much more detail than has hitherto been attempted. In this aim he may justly claim to have succeeded. The major part of the book is devoted to the working of twenty-four examples of continuous beams and single-storey portals, complete with every arithmetical detail. It is a necessary consequence of this ample treatment that the scope of the examples should be limited by space; it is perhaps surprising, therefore, that the author should have elected to devote a chapter of nineteen pages to the study of built-in beams. Might he not have presumed that a student competent to embark on the analysis of rigid frames would be already acquainted with this simpler topic? The final chapter on the analysis of a redundant pin-jointed framework by Southwell's relaxation method is a most welcome addition, although it is unfortunate that the technique should be mistakenly attributed to Hardy Cross. If the student is prepared to adopt the clockwise-anticlockwise sign convention for moments (no mention is made of the hogging-sagging convention suggested by Cross) he will find the worked examples most helpful; they are to be especially commended to those studying without tutorial guidance. The formulation of principles, however, is not altogether convincing; the method of inferring generality from the consideration of several particular cases is perhaps more exhausting than exhaustive.

SHORT NOTICES

The Story of Steel. By Max Davies. London: The Burke Publishing Company, Ltd., Price 7s. 6d.—This book, one of a series designed to give readable accounts of all aspects of British industrial achievement, deals with one of the greatest of our basic industries. The author very wisely adopts a historical approach to the subject, and, in the first half of the book, reviews the development of steel and of steel-making from the earliest times until the present day. The reader is thus prepared for the description of modern manufacturing methods which follows and is able to appreciate the advantages of the more recently developed special steels. The economic factors which have governed production and influenced the location of the industry are discussed at some length. The account of modern steel-making is well illustrated by photographs supplied by the British Iron and Steel Federation, and the close association of the author with the staff and records of BISRA has ensured accurate and up-to-date treatment of the subject. Nevertheless, misprints have crept into the names of the two ironworks mentioned on page 43, and the amounts of nickel and chromium in "stainless steel" (page 94) have become reversed. The reader interested in the uses of steel will probably wish that more than a few lines had been devoted to the characteristics of the many different kinds of steel now available for a variety of engineering applications. In all other respects the book contains a well-balanced presentation of the subject, and its interest is maintained throughout.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

QUANTUM THEORY

Sir,—I heartily support Mr. W. L. Cowley's plea appearing in The Engineer on page 685, June 9th, for a reasoned, consistent and understandable statement of the Quantum Theory in all its varied aspects, clearly describing what is known in its relation to the general body of physical knowledge, as well as defining the limitations of our informative sources.

The literature on the subject usually emphasises the distinction between microscopic and macroscopic phenomena as something new in experience, whereas it is quite familiar to students of light and heat (waves *v.* rays, molecular motions *v.* thermodynamic phenomena).

The hoary old story of the electron which jumps out of the way when looked at, intended to illustrate the so-called "Uncertainty Principle," is quite unconvincing to any one familiar with electrons and their ways *outside the atom.* What goes on within the atom may be quite another matter.

It is also quite obvious that any experiment interferes to some extent with the process observed: the usual method is a series of asymptotic approaches towards the unattainable, supplemented by many indirect procedures.

The Quantum is a case of angular momentum, whose conservation and extremal action are familiar to us. There are many well known cases of "all or nothing" occurrences, such as the eccentrically loaded roller which only goes forward when its angular momentum exceeds a swing of 360 deg. Consequently, one tends to look for rotational phenomena of very small dimensions. One such is the magnetic line, deemed the ultimate element of the magnetic field; it may not really go round, but suggestively behaves as if it did.

A comprehensible statement of *why* we do not know, and *where* information fails, is often a gain to knowledge. I think Mr. Cowley would agree with this.

Dr. Chalmers has the gift of lucid and accurate exposition, gratefully appreciated by readers of The Engineer, and we hope for more from him.

John L. Dunk

Folkestone, July 12th.

Sir,—I am interested to read in Mr. Dunk's letter that I am not alone in wishing for a reasoned, consistent and understandable statement of the Quantum Theory. The difficulties experienced by Mr. Dunk, I am sure, are common to many. His statement about the distinction between microscopic and macroscopic indicates clearly a case where the quantum physicist justifies something upon an entirely different phenomenon. We all know that the act of measurement affects to a greater or smaller extent the measurement being made. This is an easily acceptable fact. The quantum physicist, however, uses this argument in an attempt to justify something entirely different. He asserts that fundamental particles assume positions by chance, entirely uncontrolled by the laws of Nature. There is no connection whatsoever between this and the fact of interference in measurement.

W. L. Cowley

Royal Aircraft Establishment,
Farnborough, Hants,
July 18th.

PRODUCTIVITY IN BRITISH INDUSTRY

Sir,—It was with considerable interest that I read an article on "Productivity in British Industry," by Mr. Arthur Woodburn, in The Engineer of April 21st.

I think Mr. Woodburn is right when he says that the fundamental contrast between British and American methods of industry was brought about by the shortage of labour in this country and the reserve of labour there has always been in yours.

But the conditions in this country have greatly changed. On the one hand the shortage of labour has long since ceased to exist. Even in times of full employment there are from 2 million to 3 million jobless, and during depression their number has taken staggering proportions. The fear of unemployment, therefore, exists in this country just as well as in yours. On the other hand the proportion of skilled workmen has grown considerably. How then would Mr. Woodburn account for it that under conditions which in Great Britain have led to quality and specialised production, the United States still keep to mass production?

Derck Roos

California, June 27th.

Sir,—The letter from Mr. Roos is very interesting.

Of course, once a system of mass production is established it has a momentum of its own which is not affected from then on by the fact that labour is available. But in any case, the number of jobless would be proportionately so little that it would not affect the position. It is like any multiple business. If Woolworths were to put ½d. on every article they sell, they would probably increase their profits by some millions. On the other hand, a reduction of ½d. might cause losses of millions. Any slight increase in activity in the States would probably soon wipe up the small margin of unemployed.

No doubt also, as in other countries, the unemployed must be broken down into categories. There is always a section which are unemployables. They may be of the quick-witted saloon type for whom the term "spiv" was coined here some time ago. There is another section which is probably physically or mentally not up to the mark, while another section are classified as "secondary labour" who will be employed only when employers can find no one else. In some cases they are a liability and not an asset. Efficiency in industry and the resulting costs improve when these people are not required and industry can be run by first-class labour.

Unemployment is a risk which must be faced by an expanding system of productivity. I myself always advise the workers that there is no virtue in keeping people employed for too little. It is better to risk having a little unemployment by producing too much—provided the persons who increase production are not automatically punished and made poor as they were under the old unregulated system. This is really the major problem of progress—how to increase productivity without choking our well-being with unmanageable surpluses. Can the markets expand as quickly as our productivity, or can we switch the directions of our production to meet changing need?

We are not out of that wood yet.

Arthur Woodburn

House of Commons, London, S.W.1.
July 5th.

BOOKS RECEIVED

Scientist's Ready Reckoner. By W. Roman. Netherlands: Dr. W. Junk Publishers, The Hague, Netherlands. Price 15s.

Stationary Compression Ignition Engines. By C. H. Bradbury. London: E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, London, W.C.2. Price 24s.

The Properties of Metallic Materials at Low Temperatures. Vol. I. By P. Litherland Teed. London: Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 21s.

Textbook of Heating and Ventilating. By T. H. F. Holman, C. Cutler, A. H. Sandy and L. M. Clark. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 15s.

Lightning Protection of Electrical Transmission Systems

By C. J. O. GARRARD, M.Sc., M.I.E.E.

IN Great Britain the application of surge diverters and other devices for the protection of transmission lines and substations against lightning has hitherto been very much confined to certain areas in Yorkshire, East Anglia and parts of the West Country; some of the engineers responsible for these installations have stated their belief that lightning is more severe or more frequent in these parts of the country than elsewhere.

Dr. Forrest's recent paper*, however, has given evidence that this is not so, and that the likelihood of damage by lightning is very nearly equal all over the whole country.

Although the published data are, it seems, not sufficient for the question to be settled, one may, however, make the following remarks. First, Dr. Forrest's paper was concerned mainly with the 132kV grid, and his conclusions about the relative likelihood of lightning in different areas were based mainly on fault statistics of the 132kV lines. It is therefore possible that a different conclusion might be reached could a similar examination be made, say, of a 33kV network extending over the whole country.

The second point is that there are wide variations in the extent to which electric supply has been made available to the more outlying consumers. In this country "outlying" in this connection is almost synonymous with "more elevated." It follows, therefore, that 11kV, 22kV and 33kV networks designed to supply large numbers of scattered consumers are on the whole more likely to run at a higher average altitude and thus be more exposed to lightning than those serving more concentrated communities. An area like East Anglia obviously provides an exception to this statement.

The fact that a given system has less trouble with lightning than another cannot, therefore, be taken to prove that lightning in the first area is less dangerous than in the second. The nature of the job being done in the first may make the system there (other things such as insulation levels being equal) less liable to damage than is the other. It is therefore not unlikely that a re-examination of the available records might throw some light on the question of relative danger of lightning damage, provided that corrections could be made for factors like those that have been mentioned.

It is sometimes stated that the general incidence of lightning in this country does not make special lightning protection worth while. There is in fact little evidence for this statement. It is true that we have many thousands of route miles of line at 11kV, 33kV and 66kV, all without lightning protection, and that they give excellent results. It is also true that the costs of connecting consumers to our supply system are very high and are one of the main reasons why in many country districts the availability of electricity supply lags behind the high standards set by some other countries. One might, therefore, argue that the relative immunity to lightning damage had been due first to over-insulation and thus excessive expense and that the excessive expense in turn had prevented the extension of the lines into areas where lightning damage might be more frequent.

Even at 132kV, a system voltage at which it is agreed the fringe of relative immunity from lightning is being reached, 38 per cent of all faults in this country are due to lightning. At lower voltages the proportion is probably higher. Although the fault record of our systems is very good, any means which may result in a further 30 or 40 per cent reduction in the number of faults is plainly worthy of examination.

If, as we all hope, the establishment of the Electricity Boards will give a new and general impetus to rural electrification, lightning protection will acquire a new importance because of the very large extension of 11kV, 33kV and 66kV overhead lines that will have to take place. The impending development also gives an opportunity, which has never existed before, of making large-scale controlled experiments with the possible alternative methods of lightning protection and even of throwing some light upon the most fundamental question of all, namely, at what degree of immunity from lightning outages one should aim, or, rather, at what degree is it economically most advantageous to aim.

Lightning protection is, of course, in some respects only one part of the general problem of earth fault protection, so that it is impossible to consider lightning damage and earth faults due to other causes as two entirely separate matters. Nevertheless, a high proportion of all earth faults is caused by lightning, and many of the remaining earth faults are indistinguishable in their immediate effects on the network, from those caused by lightning. It seems, therefore, that if one considers the matter primarily from the point of view of lightning protection, one deals with the main part of the problem and has the advantage of a uniform point of departure in each case. This is of particular importance, for example, in dealing with the arc suppression coil, and in assessing its value as an alternative or a supplement to other methods of earth fault protection.

If, as it is part of the object of this article to urge, experiments in lightning protection should be undertaken, it is necessary to single out a few clear alternatives from the many possibilities that present themselves.

The following are some tentative suggestions.

First, as a control there should certainly be one area in which the protection consists merely of the provision of strong transformer insulation and suitable grading of the external insulation. The grading should preferably be in two steps provided by horn gaps in the line insulators and rod gaps in the stations set to a slightly lower value.

Such a system could not be expected to give good service unless the setting of the rod gaps was fairly high; this in turn would need highly insulated transformers.

An alternative might be a system with less highly insulated transformers and correspondingly reduced rod gap settings, combined with an arc fault suppression coil for the clearance of transient earth faults including those caused by the spark-over of protective rod gaps.

Another alternative might be to provide a system with lightning protection in the form of surge diverters or equivalent devices giving a high degree of protection (i.e., having a low residual voltage) and transformers with correspondingly reduced insulation. Different parts of the system could be provided with different protective devices, provided that all had the same protective level. Line insulation gaps could be set at such a value that outages due to spark-over were so few as not to be troublesome.

It seems that such a series of experiments as this would not be very costly, as presumably the selected systems would in any case have to be protected in some way. It would, however, provide data for future development, which could be obtained in no other way, and provide great assistance both to the supply authorities and to manufacturers, who at present are compelled to make recommendations for the installation of protective devices upon what is frequently a very scanty basis of documented operational experience.

* "The Performance of the British Grid in Thunderstorms," Institution of Electrical Engineers, (Supply Section) December 14, 1949.

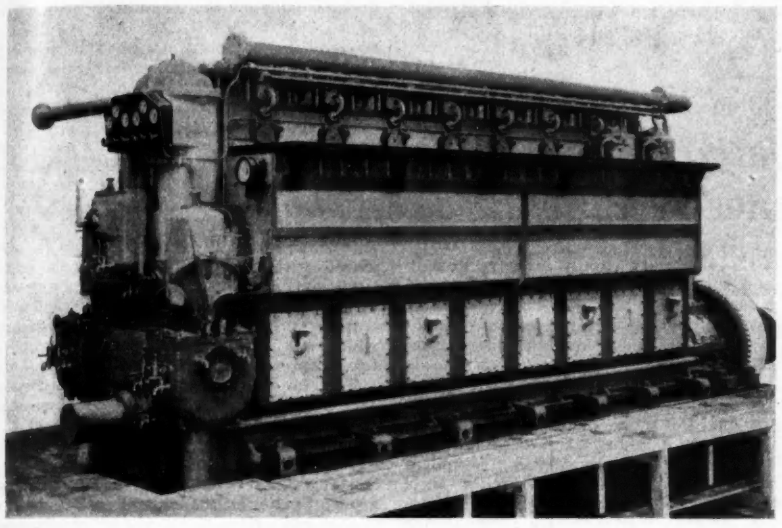
Lloyd's Register Shipbuilding Returns

THE returns published by Lloyd's Register of Shipping for the quarter ended June 30, 1950, indicate that in Great Britain and Northern Ireland, 1,937,191 gross tons of shipping were under construction, representing an increase of 41,972 tons compared with the previous quarter, but a decrease of 306,512 tons on the record tonnage building at the end of June, 1948. The tonnage for abroad slightly increased to 738,265 tons, being 38·1 per cent of the tonnage building in this country, and of that tonnage, 142,383 tons were commenced during the June quarter. At 2,612,730 tons, the amount of steam and motorships building abroad was 176,725 tons less than in the previous quarter, but no figures are available for Poland, China, Germany and Russia. The world total tonnage of steamers and motorships—apart from the countries excluded—was 4,549,921 tons gross, of which 42·6 per cent was building in Great Britain and Ireland, representing a decrease of 134,753 tons compared with the preceding quarter. In Great Britain and Ireland 372,433 tons of steamers and motorships were laid down, 484,873 tons were launched and 345,614 tons completed, the corresponding figures for abroad being 321,311 tons, 525,465 tons and 484,059 tons respectively. The construction in Great Britain and Northern Ireland consisted of steamers 713,418 tons, and motorships 1,223,773 tons, while the corresponding figures for abroad were steamers 902,923 tons and motorships 1,709,807 tons. World construction of steam and motor oil tankers of over 1000 tons gross amounted to 173 ships totalling 1,877,049 tons, being an increase of 52,131 tons since the end of March, and representing 41·3 per cent of the total tonnage building. Of this tonnage 90 ships of 988,787 tons are under construction in Great Britain and Northern Ireland. Of the world tonnage, 62·6 per cent or 2,845,809 tons are being built under the inspection of Lloyd's Register, 1,789,204 tons in Great Britain and Northern Ireland and 1,056,605 tons abroad.

CAMBRIDGE UNIVERSITY ENGINEERS' ASSOCIATION.—A dinner was recently held by the Cambridge University Engineers' Association in honour of Sir Charles Inglis. It was attended by 162 engineers, the chairman being the Master of St. Catharine's College. The toast to Sir Charles was proposed by Sir Geoffrey Burton, and the toast to "The Association" was proposed by the Provost of King's College and replied to by Professor Baker. Professor Inglis made a vigorous speech in reply to the toast to his health, during the course of which he remarked that education could not be likened to a pump which was pumping water into a cistern at a uniform rate. He also remarked that over-efficiency in education might well be the mother of mediocrity.

The Clark-Sulzer-Engined Collier, "Portsmouth"

THE motor collier "Portsmouth" owned by Stephenson, Clarke, Ltd., is noteworthy as being the first collier to be powered by a Clark-Sulzer engine. The vessel, which is now in the service of the Southern Gas Board, carrying coal from the north-east coast to Portsmouth, was constructed by John Crown and Sons, Ltd., and engined by George Clark (1938), Ltd. The "Portsmouth," a self-trimming collier with raised quarter deck, bridge amidships and machinery aft, conforms to the normal design for this class of vessel. She has a length between perpendiculars of 253ft 6in, a breadth extreme of 38ft 3½in, a depth moulded to upper deck of 18ft 8in and 22ft 9in to the raised quarter deck and carries 2500 tons in four holds on a draught of 17ft 4in.



ENGINE ON TEST BED—PORT SIDE

General Design of Engine

The single-screw machinery, shown in our illustrations on the test bed, is the first Sulzer diesel engine built by George Clark (1938), Ltd., and consists of an eight-cylinder unit of the single-acting, airless injection, two-stroke, reversible trunk piston design, developing 1125 b.h.p. at 220 r.p.m., with a b.m.e.p. of 68 lb per square inch and having a bore of 360mm by 600mm stroke. The engine works on the direct fuel injection system and each cylinder has its own double-acting scavenge air pump fitted with automatic streamline valves and driven by a rocking lever from a main connecting rod. The arrangement of separate scavenge pumps results in certain advantages, which ensure uniform delivery of scavenge air, quiet suction, favourable balance of the reciprocating masses, an engine of minimum length and production efficiency because each cylinder and pump unit are identical, making maximum standardisation possible. There are no automatically operated scavenge air valves in the system. The piston uncovers the exhaust ports just before bottom centre and then the scavenge air ports, which connect with the scavenge air trunk by inclined passages. The design of the ports is such that complete scavenging is claimed using the minimum amount of air and power and a low fuel consumption is indicative of the efficiency of the system.

Two of the piston scavenge pumps have small air compressors built on to them. These compressors are driven by the pump piston rods and charge the starting air reservoirs, there being an automatic cut-out when the designed pressure is reached. At the forward end of the engine are two engine-driven reciprocating pumps, one for the circulation of the cooling water and the other connected to the bilge line, arrangements being made for the bilge pump to take over the duties of the circulating water pump. In addition, there is an oil pump driven by spur gears from the crankshaft for the lubrication and piston cooling systems.

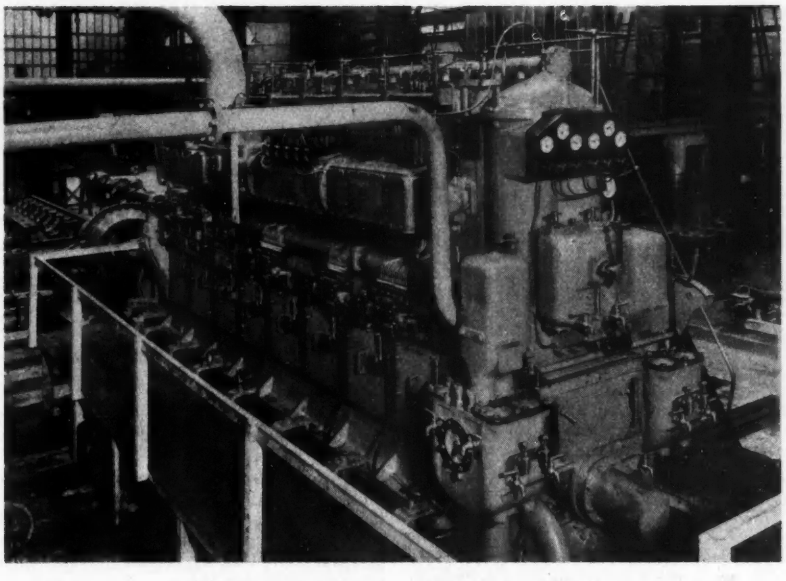
Construction and Materials

The cylinder block and upper part of the crankcase are a monobloc casting incorporating removable special wear-resisting cast iron liners, which are fixed at the top flange and are free to expand downwards in water-tight seals formed by rubber rings. Examination and overhaul are facilitated by the fitting of large inspection doors in the cylinder block, which give ready access to the crankcase, and by handholes, which ensure easy access to the cooling spaces between cylinder block and liner. The water-cooled cylinder heads are each fitted with a pneumatically operated starting valve, a fuel valve, a relief valve, and an indicator cock. A nozzle at the inlet circulates the cooling water, while inspection doors allow the cooling spaces to be cleaned.

The trunk pistons each have five cast iron compression rings above the gudgeon pin and three scraper rings at the bottom of the skirt and are withdrawn by lifting gear arranged over the engine. Cooling of the pistons is by lubricating oil led through telescopic steel tubes fitted in brackets attached to the frame. The oil returns to the crankcase through a pipe having an outlet below the oil level in the sump and then flows to the lubricating oil pump, which passes it through a filter and a cooler before recirculating. The same pump serves the forced lubrication system and a spring-loaded valve on the delivery side regulates the oil pressure and serves as a relief valve. In order to avoid change in direction of flow when the engine is reversed suction and delivery valves are fitted on each side of the two pumping wheels. Mechanical lubricators built in to the engine and driven by the camshaft lubricate the cylinders.

The top end of the connecting rod, which is a solid forging machined all over, is spherical and is fitted with a bronze bush to take the gudgeon pin. Two bolts fasten the flange at the bottom end to the steel bottom end bearing, which is lined with white metal and has shims for clearance adjustment. Main bearings between each crank support the crankshaft, the aft end of which is forged to form the coupling to the thrust shaft. A cast iron fly-wheel equipped with hand turning gear is attached to the thrust bearing shaft and there is a single collar nickel thrust bearing, lubricated from the main engine, with its casing flanged to the engine bedplate to form a compact unit. There are no lubricating oil passages in the crank webs or pins. The main bearings are carried by ribbed girders in the bedplate, which is in one piece and provided with a welded steel oil trough containing the lubricating oil pump suction pipe.

The eight fuel pumps, designed for variable timing of injection, are mounted in one block close to the crankshaft, from the after end of which they are driven by gearing. A centrifugal governor mounted on the aft end of the camshaft controls the engine speed by regulating the fuel pump delivery and the



ENGINE ON TEST BED—STARBOARD SIDE

gear and linkage are arranged to act throughout the speed range. This arrangement prevents racing due to the propeller lifting from the water and limits the increase of engine speed to between 10 and 15 per cent of the revolutions corresponding to the position of the speed control lever. A common water-cooled exhaust manifold of cast iron is connected directly to the cylinder block. Each manifold branch is fitted with an inspection cock for observation of the exhaust gas from individual cylinders and doors give access to the exhaust ports and manifold cooling spaces. The simple control gear consists of one combined starting and reversing lever and a lever for fine adjustment for speed regulation.

No results of the performance of the engine in service have been received but test-bed results after three hours' running at 100 per cent loading indicate that the engine developed 1160 b.h.p. at 223·5 r.p.m., with a b.m.e.p. of 67·9 lb per square inch and scavenge air pressure of 1·96 lb per square inch. The exhaust temperature and pressure was 470 deg. Fah. and 8in w.g. respectively, and the fuel consumption was returned at 0·37 lb per b.h.p. per hour.

The Clark-Sulzer marine engine, Mark T.D.36, is a development of the engines built in 1933 and it is proposed to build this mark of engine in units from four to twelve cylinders, with a horsepower range of 720 to 2160 b.h.p. at 250 r.p.m. It is understood that another design, T.P.D.48, having a cylinder diameter of 480mm and a stroke of 700mm and the scavenge pump mounted at the forward end of the engine, is to be manufactured, the four-cylinder model developing 1300 b.h.p. and the twelve cylinder model having a rating of 3900 b.h.p., both at 225 r.p.m.

British Electricity Research Laboratories at Leatherhead

THE British Electricity Authority's new research laboratories at Leatherhead which were opened recently by Lord Citrine are on a more modest scale than some of the corresponding organisations abroad. They are, however, deliberately conceived and admirably equipped to complement the existing research facilities of the E.R.A., the leading electrical manufacturing firms, the National Physical Laboratory and of the B.E.A. power stations. Although these older establishments served most of the electrical industry's requirements for pure and applied research, the growth of the national grid emphasised the need for a central organisation to study, both in the laboratory and in the field, the high-voltage transmission problems which were being met for the first time in Great Britain.

Among the more pressing problems, for example, were those associated with the performance of 132kV overhead line insulators in humid atmospheric conditions aggravated by industrial pollution. To study the transmission difficulties that were encountered the Central Electricity Board built a small laboratory at Waddon in 1932. Two years later a high-voltage insulator testing station was set up at Croydon. Plans for establishing bigger laboratories were postponed on the outbreak of war in 1939. Enemy action in August, 1940, caused the work that was being done at Waddon to be transferred to Leatherhead on vacant land adjoining the C.E.B. 132kV transformer station. Later, 250kV test equipment was moved to this site from the insulator testing station at Croydon.

Further developments at Leatherhead were delayed by post-war difficulties, but nationalisation of the electricity supply industry greatly increased the scope of the C.E.B.'s plans for new laboratories. The newly created central authority was charged with the task of conducting research on generation and distribution as well as transmission, to serve its own needs and those of the fourteen generating divisions and area boards.

Work on the new laboratory buildings, modified where possible to meet these new requirements, began in June 1948. The offices and most of the laboratories (under their director, Dr. S. J. Forrest) were in use eighteen months later, although some of the heavier test equipment has only recently been installed.

The Laboratory Organisation

A brief visit to the Leatherhead laboratories a week ago gave us an opportunity of learning from Dr. S. J. Forrest something of the organisation and of seeing it at work. Its purpose, working in co-operation with the other research organisations to avoid duplicated effort, is to solve any of the technical difficulties that may arise in the electricity supply industry. Both long term and short term investigations are included in its activities and one of its main tasks is to examine and test materials and components submitted by the generating divisions and electricity boards.

The laboratory organisation is divided into seven sections, dealing with the following subjects: transmission and distribution, electronics and instruments, generation (special problems), mechanical engineering, physics, chemistry and photography. In addition, there is an insulator testing station at Croydon for field experiments.

A frontal view of the Leatherhead laboratories, with a test tower in the background, is reproduced herewith.

Transmission and Distribution

Technical problems associated with the operation of the grid transmission system and the distribution network are the concern of the transmission and distribution section which is equipped with a high-voltage laboratory and low-voltage laboratory and an experimental high-voltage line at Leatherhead.

Apparatus installed in the high-voltage laboratory is capable of providing power frequency voltages up to 250kV (r.m.s.), d.c. voltages up to 200kV, and impulse voltages up to 1400kV (peak). Impulse and power frequency wave forms can be recorded on cathode ray oscillographs and power factor measurements at voltages up to 250kV (r.m.s.) can be made on a Schering bridge.

One of our illustrations gives a general view of the high-voltage laboratory showing a power frequency test, at 150kV, in progress; on the right is an observation gallery and below it is the control station in which the operators at the control desk are protected by a screen glazed with toughened glass panels and by electrical interlocks on the doors giving access to the high-voltage area. This particular illustration does not show the impulse generator which was installed after the photograph was taken, approximately four weeks ago.

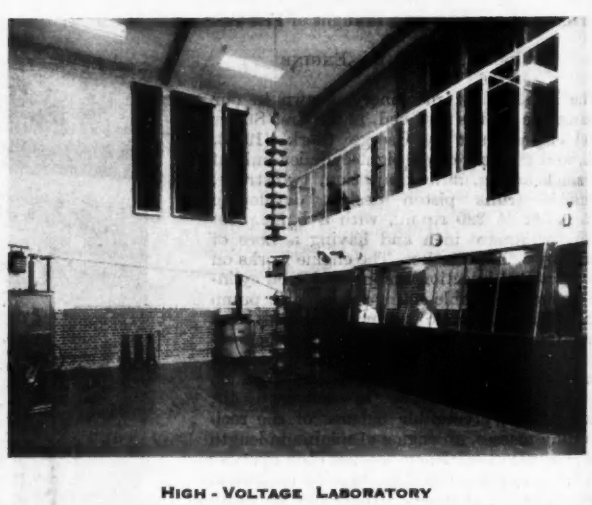
The impulse generator is a conventional eight-stage equipment consisting of resistance arms and 0·16μF condensers arranged to be charged in parallel, with a charging voltage of 175kV per condenser, and to be discharged in series. Discharge is initiated by depressing a push button on the control desk and the discharge gap setting can be varied by servo-motor drive which is also under push-button control by the operator.

All the controls for the high-voltage area and the Schering bridge are centralised on a desk immediately in front of the operator. Push buttons control the motor-operated induction regulators for raising or lowering the power frequency a.c. voltage. The instrument pointers and scales are coated with fluorescent paint and can be illuminated from above with ultra-violet light, allowing readings to be taken when the laboratory is in darkness.

For handling equipment in the high-voltage area there is an electric crane operating along runways, portions of which can be seen against the ceiling of the laboratory in our illustration. The runway points are power-operated: switching of the runway and all movements of the crane are remotely controlled by push buttons on the operator's desk.

One of the photographs reproduced opposite shows the low-voltage laboratory, which is equipped for general electrical investigations

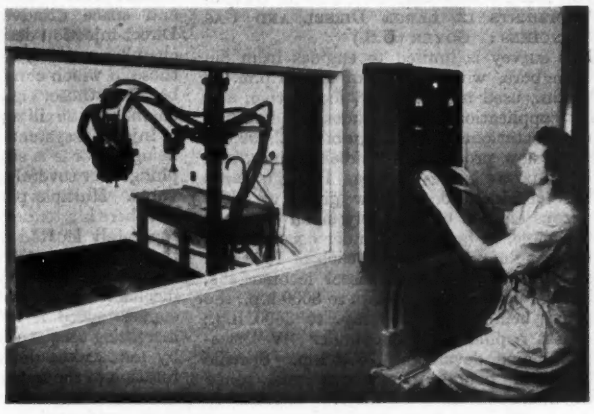
General View of B.E.A. Leatherhead Laboratories



High-Voltage Laboratory

and measurements. An important part of its work is concerned with recording electrical data on the grid system during normal operation and fault conditions. The four equipments in the background of our illustration include, on the right, a Schonland lightning recorder which is capable of distinguishing between near and remote disturbances. The second cabinet from the right is arranged to record meteorological measurements affecting power demand, so that the influence of weather on power system load can be studied. On the extreme left is a frequency recorder carrying two clocks giving "standard" time and "power-frequency-controlled" time respectively, whereby investigations can be made of the incidence of peak loads and their effect on frequency and time measurement.

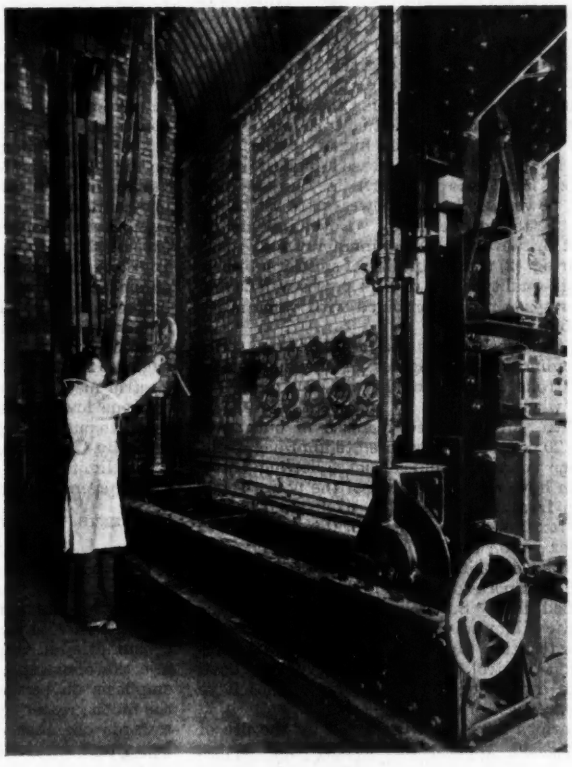
LOW-VOLTAGE LABORATORY



RADIOGRAPHY LABORATORY CONTROL ROOM

In our issue dated March 3, 1950, p. 266, we described and illustrated the experimental high-voltage line which is erected on open ground near the laboratories. No further reference to the subject need be made here except to point out that the line is energised at 275kV for investigations of its mechanical performance, radio interference, power loss due to corona and insulator leakage in various weather conditions.

The insulator testing station at Croydon is designed for carrying out field work complementary to the laboratory studies at Leatherhead. An 85kV outdoor test plant is arranged for the life-testing of insulators under conditions approximating closely to those of service in polluted atmospheres. Instruments recording leakage current and the incidence of leakage current surges are used for continuous supervision of the appropriately mounted insulators. At present, work is in progress on the characteristics of insulators embodying semi-conducting glaze and on methods of washing the insulators of live lines.



24,000 LB TESTING MACHINE

Methods of adapting electronic techniques to power system operation form an important part of the work of the electronics and instruments section. Its activities include v.h.f. radio communication and the possibilities of applying micro-wave technique as an alternative to carrier current working on pilot wires as a link in protective systems. Electronic apparatus is also being developed for strain and pressure measurements, with particular reference to the forces developed in circuit breaker enclosures. In other directions, progress is being made with thunderstorm recording, fault recording instruments and interference with television and radio reception.

Special generating problems, including vibration, rotor winding failures and moisture precipitation from cooling towers come within the province of the generation section.

Special attention is being given to the subject of precipitation; an experimental cooling tower has been built at Croydon, with facilities for making carefully controlled tests on various designs of packing, water distribution systems and particle eliminators. Provision is made for varying the rates of water and air circulation and collecting and measuring any moisture borne out of the tower by the air. At the same time, methods are being developed for measuring precipitation from full-scale cooling towers and for assessing the effect of air flow on their performance.

The mechanical engineering section is concerned, in general, with the testing of materials, and, in particular, with the measurements of the ultimate tensile strength of overhead line conductors and joints and (in co-operation with the chemistry section) the study and assessment of conductor deterioration. A particular function of the mechanical engineering section is to ensure that new designs of overhead-line joints satisfy the specification for mechanical strength before being accepted for service.

The laboratory equipment includes a testing machine (illustrated herewith) for measuring the ultimate strength of conductors and joints up to a total loading of 24,000 lb. Our illustration shows the machine being used to determine the strength of a "compression" joint and "snail" clamps assembled on a steel-cored aluminium overhead-line conductor. For similar tests on single strands of conductor, involving loads up to 2 tons, use is made of smaller machines, such as the Hounsfield tensometer.

Particular physical problems arising out of the work of other sections are dealt with by the physics section. Work in progress includes a study of the behaviour of semi-conducting ceramic glazes at low temperature.

An important function of the physics section is to provide a radiographic service for the other sections. The equipment, part of which is illustrated herewith, consists of a 140kV X-ray plant in an operating room shielded from surrounding rooms by sheet lead in the floor and doors and by concrete wall blocks containing barium. As illustrated herewith, the X-ray set is operated from a panel in the adjacent control room, which is fitted with a lead-glass observation window giving a full view of the X-ray room. Electrically interlocked communicating doors complete the protection.

Radiography offers a valuable means of making internal examinations of overhead-line joints, condenser bushings and traction batteries. An interesting technique has been developed for use when it is desired to have a radiographic record of surface as well as interior condition. By applying a thin coating of opaque material to the surface, the latter can be rendered "semi-transparent" to X-rays, with the result that an image of the surface appears superimposed on the image of the interior—at the expense of some loss of definition.

The chemistry section, like the physics section, exists for the service of the other departments. Its equipment includes a Hilger "Spekker" for colorometric analysis, and portable instruments for measurement of pH values and conductivity.

An important item in the present programme of work is a study of the possible correlation between impurities in aluminium conductors and the rate of deterioration in service. In passing, it may be mentioned that, since the aluminium in question is nominally 99·5 per cent pure, the investigations involve the measurement of impurities of the order of 0·03 per cent or less. Insulating oils claim much of the section's attention and the laboratory is taking part in an international programme on oil oxidation organised by C.I.G.R.E.

Fourth World Power Conference

No. III—(*Continued from page 78, July 21st*)

WE continue below our abstracts from the "general report" papers of the Fourth World Power Conference.

PAPER No. 2: SUMMARY OF CURRENT DEVELOPMENTS IN LARGE DIESEL AND GAS ENGINES: BOYER (U.S.)

This survey is limited to engines from 8in to 32in bore, with speeds of 1200 r.p.m. to 84 r.p.m., used in stationary, locomotive, and marine applications, and includes the dual-fuel type. In stationary practice, about 12,000,000 h.p. are now produced by diesel engines, and an equal power by gas engines. In large plants serious consideration is now given to more numerous engines of relatively small outputs; for example, in one plant, under construction, 120 gas engines will be used, each of 1650 h.p. There are nearly 10,000 diesel locomotives, ranging in power from 600 h.p. to 8000 h.p., the majority being from 1500 h.p. to 2000 h.p.; the most popular is a 16-cylinder "V" two-stroke engine developing 1500 h.p. Specific weights, in pounds per horsepower, range from under 20 for locomotive engines to 150 to 200 in slow direct-driven marine engines, with, however, 50 to 60 in marine and stationary engines of 2000 h.p. to 4000 h.p. Specific consumptions of fuel oil of 0·36 lb per brake horsepower hour are common, while improvements to gas engines have reduced values from 10,000 to 6500 B.Th.U. per brake horsepower hour. Probably 50 per cent of diesel engines, and a much higher percentage of gas engines, are two-stroke, although four-stroke engines predominate for cylinder diameters below 18in.

Two-stroke engines generally employ uniflow scavenging at high speeds, and loop scavenging at low. Supercharging is increasingly applied, the rotary positive blower being the most popular means. In four-stroke diesel engines, sixteen out of seventeen builders use turbo-charging, the so-called low-pressure system predominating, although higher pressures are rapidly becoming popular. The after cooling of supercharging air is not common.

The gas engine is now of outstanding importance, especially for gas transmission; combined engine and compressor units in "V" form are common, the engines up to 2500 h.p. being mostly two-stroke, although for the supercharged and gas-diesel types four-stroke working is preferred. A vital recent development is that of the gas-diesel or dual-fuel engine, which has recently become intensely popular in regions with cheap gas. They are injection engines running normally on gas but convertible to oil when gas supply is restricted; on gas, they have a favourable specific consumption on load.

The cast frame is again becoming a serious rival to the welded. Cast crankshafts are widely used. Modern bearings are precision-produced and designers favour thin-shell babbitt, with both lead and tin bases. Pistons are of cast iron or aluminium, the former predominating; and designs involve thin sections behind the rings to facilitate heat transfer to the cooling fluid, which is often oil. Piston rings tend markedly towards decreased widths. Opinions are divided concerning the chromium plating of liners. Valves are mostly composite and welded; valve cages are disappearing. Combustion chambers above 8in bore, in both two-and four-stroke working are nearly all of the direct-injection type. Impulse pumps are very common, and some are in the form of unit injectors. In large marine engines constant-pressure or "common rail" injection is still employed. Most cooling systems involve closed circuits with tendencies towards the use of radiators and a small rise of temperature of the water; the temperatures are higher and, with steam under pressure, may even reach 240 deg. Fah.

PAPER No. 3: SUMMARY OF CURRENT DEVELOPMENTS IN SMALL DIESEL ENGINES: BENNETT (U.S.)

This survey is restricted to engines of below 8in bore. Outputs up to 550 h.p. are available at 1000 r.p.m. to 3000 r.p.m., in engines of from one to twelve cylinders, in "V" or "in-line" forms, the latter being horizontal or vertical. Recent practice has reduced the relative weight and space disadvantages of diesel engines. Direct-injection designs are less numerous than chamber engines, the latter being divided into those in which combustion occurs in the chamber, and those, e.g., the Lanova, in which the chamber is auxiliary to the combustion.

Injection systems are diverse, a recent trend being towards a single metering and pumping plunger for several cylinders, with a distributor valve. Multiple plunger pumps are still built, but there is a tendency towards individual units separately located near each cylinder, eliminating pipes. Speed control is always by spring-loaded rotating governors controlling injection mechanically or hydraulically; in automotive engines speed is limited by vacuum control; increasing torque at decreasing speeds is secured by mechanical devices further controlling the rotation of the metering plunger; in some units the beginning of injection is also varied to accord with engine speed.

Fuels have deteriorated as regards sulphur content, and the resulting accumulations of gums and lacquers have hastened the gumming of piston rings and have corroded liners, thus leading to increased wear. Suitable lubricants to counteract these adverse effects are being developed. As regards fuel economy, the difference in price between gasoline and diesel fuels has steadily decreased in recent years.

PAPER No. 6: RECENT DEVELOPMENTS IN LIGHTWEIGHT SPARK-IGNITION AND COMPRESSION-IGNITION ENGINES: ROBOTHAM (G.B.)

The paper, which is in two parts, deals almost exclusively with engines for land transport—spark ignition and compression-ignition engines, respectively, forming the two subjects. In the former, the specific fuel consumption has been improved mainly by higher octane numbers in the fuel and increased highest useful compression ratio (h.u.c.r.) in the engines. High power-weight and power-space ratios are now better appreciated. Developments in Great Britain are: (1) maximum rationalisation of parts; (2) the production of smaller numbers of high-quality units, of high power-weight and power-space ratios combined with outstanding durability.

In twenty-six years the output of one series of 6-cylinder petrol engines, of unchanged bore and stroke, has increased from 48 h.p. to 145 h.p., with less than 10 per cent increase in weight. An estimated increase in output of 15 to 20 per cent is attributed to improved fuels. Higher volumetric efficiencies following better design have raised the peak of the power-speed curve from 2500 r.p.m. to 3750 r.p.m. The new tax system in Great Britain encourages shorter piston strokes and multibank engines. For vehicle engines, where high torque at low speed is important, petrol injection has not yet justified itself. Supercharging suffers from the absence of blowers with good efficiency and speed characteristics. In spite of researches on combustion control, opinions on cylinder head design are divided. Two-stroke engines have little prospect of use in transport.

Bearings have been improved by the use of pre-finished replaceable copper-lead types. Exhaust valves are now of austenitic or silicon-chromium steels, sometimes hollow with sodium filling to assist heat flow from the head. Cylinder bores are frequently chromium-plated, reducing wear to one-tenth. Torsional vibration troubles at higher speeds and loads are reduced by stiffer crankshafts and improved dampers. Improved piston rings give better oil control. Directional control of coolant circulation has assisted heat flow from exhaust valve seats. A material contribution to improvement in reliability has been the provision of better lubricants.

Greatest weight decrease has followed the use of light alloys for cylinder-head and cylinder-block castings. A light-alloy passenger car engine could be produced giving 33 brake horsepower per litre and 3 lb per brake horsepower, including all accessories, manifolds, and flywheel.

Automatic transmissions eliminate full engine torque at low speeds; deprive a driver of the ability of using full power at maximum torque for long periods; reduce cruising and maximum engine speeds; and improve fuel economy.

The view is expressed that petrol engines of the same power-weight ratios and costs would be comparable with compression-ignition engines as regards reliability and durability. British compression-ignition engines for vehicles have been influenced by legal restrictions in size and speed, and engines of 100 h.p. for 22 tons have resulted. These are light and compact, but there is no special demand for weight reduction. In passenger vehicles, bulk is more important, and engines have been placed under the floor. From 100 b.h.p. to 300 b.h.p. and higher. British engines not for road vehicles have lower power-bulk and power-weight ratios. Emphasis on fuel economy has led to the predominance of direct-injection heads. In America, there are fewer restrictions to weight and speed, and, with lower fuel prices, performance is more important than fuel economy, so that many divided combustion heads are found and the two-stroke engine is popular. The latter is superior in power-bulk and power-weight ratios but inferior in fuel economy.

Regrettable British restrictions of load and speed have retarded supercharging, which improves running as regards silence and smoothness, gives a better ratio of maximum pressure compression, gives better combustion, a greater air utilisation and a possible higher speed, facilitates use of fuels of low cetane and volatility, and reduces coolant heat per brake horsepower. Cooling the air from the supercharger is desirable, to lower the cycle temperatures. For greater fuel economy, better pistons and rings should follow research; four valves instead of two, would improve air charging and increase the power; automatic transmission can also contribute to economy in fuel by causing an engine to run under optimum conditions. For better durability—in addition to Stellited valves, nitrided crankshafts, copper-lead bearings, chromium-plated or chromium-steel liners—lubricant additives, to prevent ring sticking, extend the specific output between overhauls. Injection-pipe breakage should be avoided by eliminating forced vibrations and by using better materials. For weight reduction, while greater use of light alloys is recommended, no overall advantages can be seen in multi-bank engines. For starting, the author prefers the electric method, with an ether carburettor for extreme low temperatures. In Great Britain, separate pump and governor units, such as those made by C.A.V. and Simms, are universal, and do not limit output or economy. Pilot injection shows promise of reducing diesel knock.

COMMENTS UPON THE PAPERS, AND SUGGESTIONS FOR DISCUSSION

Papers Nos. 1 and 6 from Great Britain, and papers 2 and 3 from the U.S.A., cover much interesting, but common, ground. One point for discussion is that the emphasis on low fuel consumption in Great Britain, for which direct-injection engines are favoured, contrasts with the emphasis on performance in the U.S.A, and the much greater tendency in the latter country towards chamber cylinder heads, the Lanova being prominent. Two-stroke working is also more popular in the U.S.A. Starting methods at low temperatures could well be discussed. While low-pressure supercharging is more widely used in the U.S.A., interest might be focused on the higher supercharge and mean pressures proposed in Great Britain, brought about by the desire for low specific weights, coupled with low consumptions. Practice in injection systems is different, the multi-plunger pump supplying separate injectors being favoured in Great Britain, while many of the diverse systems in the U.S.A. embody separate pump-injector combinations. Interest-

ing points are also the control of torque at decreasing speeds, the variation of injection with speed, and pilot injection. Comment on fuels with higher sulphur content is common in both countries. The large power developed in gas engines in the U.S.A., 12,000,000 h.p., will surprise many, as well as the success of gas-oil convertible engines. In the case of large-powered installations, an interesting contest is taking place between large units and multiple smaller units.

SECTION G.—GAS TURBINES AND JET ENGINES

By H. Roxbee Cox, B.Sc., Ph.D., M.I.Mech.E., F.R.Ae.S.*

The papers contributed to this section cover a great deal of ground. The gas turbine is discussed in relation to power generation and aircraft propulsion; its use in land and marine propulsion is touched upon; its possibilities as an auxiliary to, or as a partner with, other forms of heat engine are discussed; and some of its potentialities as a component in industrial and chemical processes are indicated. The applications of the gas turbine are now so numerous, however, that we can no longer expect, even in a session embracing seven papers to cover all the ways in which it can be employed. It may well be, therefore, that in addition to discussing the many matters arising naturally from the papers, members may wish to make the session of the maximum use by also developing points which have only been lightly touched upon in the papers, and contributing their views and experiences on aspects of the gas turbine which the papers may not cover.

Two features are particularly noticeable in the papers presented in this section. The first is the apparently overwhelming appeal to engineers of the open cycle, an appeal which I do not feel is fully explained. With the notable exceptions of the Escher Wyss Company, in Switzerland, and the John Brown Company, in Scotland, there do not seem to be any serious exponents of the closed cycle system. So far as America is concerned, Rowley and Skrotzki believe that the dominance of the open cycle there is due to the belief that commercial success under conditions in the U.S.A. demands the simple and direct solution, a view influenced, they suggest, by aircraft gas-turbine design, for which the open cycle is universally accepted as the most suitable. It would be worth hearing the views of the closed and mixed-cycle proponents on the simplicity and directness of the open-cycle solution. So long as an atmospheric-air boiler can be conveniently used in the closed cycle—and the latest designs employing radiant heat are certainly attractive—the closed cycle has no problem of blade fouling and corrosion due to combustion products. It has still, indeed, a corresponding problem in the heat exchanger, but so has the open cycle engine. What Keller describes as "astonishingly small rotor dimensions" are also achievable with the closed cycle, and I think it would be worth while for the closed cycle experts to emphasise the merits of their choice in our discussion.

My suggestion is that the relative merits of the two main cycles are not reflected in the dominating position occupied by the open cycle, and that before acquiescing in the current trend we might be wise to take stock.

The second noticeable feature is the almost universal adoption of the axial-flow compressor. For a long time British aircraft gas-turbine practice was dominated by the centrifugal compressor, and a great deal of the early success of the aircraft gas turbine was attributable to the robustness and flexibility of this type of compressor. It still holds a place in the air, but the demands of small frontal area for high-speed air travel are squeezing it out. Moreover, in heavier applications of the gas turbine there is a striking addiction to the axial-flow compressor, an addiction to which only the Oerlikon Company in Switzerland, and the De Laval and Elliott Companies in America, appear to have any antidote. Certainly there are some very small gas turbines, such as that of the Rover Motor Company, with centrifugal compressors, but one cannot help wondering whether they have been adopted only because of the manufacturing difficulties of making very small axial compressors.

Now that, as the papers by Smith, Roy and Rowley and Skrotzki make clear, coal-burning gas turbines are being developed, one cannot but feel that the robustness of the centrifugal compressor may not make it the more suitable choice in some applications. It is probable that the axial compressor will always keep a little ahead on efficiency, but it is evident from the Oerlikon work and from aircraft practice, that highly efficient centrifugal compressors are possible, and again I feel that while the axial compressor may more often be the more suitable choice, the strength of the present bias towards the axial compressor is not entirely justified.

The choice of rotating compressors is not, of course, universal, and there must continue to be great interest in the displacement compressor particularly in the free-piston compressor which is discussed by Roy in the section of his paper dealing with the "Système Equipression" of Mercier. Roy sets out in his paper the advantages of this system, which include an extremely compact boiler, and a thermal efficiency of the order of 40 per cent—an efficiency which it will not be easy to equal by other means. He also discusses another combination of rotating and reciprocating machinery in the "Système Mototurbine," a development which, he suggests, is particularly suitable in certain conditions for rail traction and the propulsion of light ships. The other paper in which the gas turbine appears in association with more conventional machinery is that by Karrer. He gives the theory of the combination of the gas turbine with an efficient condenser steam turbine for power generation, and he thereafter discusses the practical example which demonstrates a substantial improvement of the combined system over that of the steam plant alone. He finds that a steam-gas system can also be expected to give a thermal efficiency of the order of 40 per cent. The possibility of the conventional gas turbine alone reaching this figure would be worthy of comment.

Karrer's paper also discusses the use of exhaust gases from high temperature processes, such as glass factories and cement kilns, as the heat supply to the gas turbine air. He also deals with the use of gas-turbine exhaust gases for supplying heating for low-temperature processes such as drying or as pre-heated combustion air supply for furnaces. These are interesting examples of a wide variety of uses to which the gas turbine may be put to increase the efficiency of industrial processes.

Smith makes it clear in his paper that the future utilisation of the gas turbine is largely dependent upon its ability to burn cheap fuel. In consequence we find, in all the countries in which gas turbine development is taking place, a drive towards making gas turbines run on residual oil and on coal. In addition, in Great Britain work is in hand to adapt the gas turbine to running on peat. The nature of the residual oil burning problem is now well known. As Smith says, "widely varying experiences have been reported, but it is clear that at least some gas turbines can run successfully on some residual fuels." We want to reach the stage, however, of being able to design a gas turbine to run successfully and consistently on any given residual fuel, and we have not reached that stage yet. Cleaning the gas not only of solid matter but of deleterious gaseous matter is the target of a great deal of current research and experiment. In the case of coal the major problem is to find satisfactory means of preventing solid material of a damaging size from passing through the turbine. It is not, I think, yet agreed what is the largest size of particle which can be permitted to reach the turbine blades. Some believe that particles smaller than 10 microns will not have any damaging effect. Others have put the limit as high as 20 microns.

Two of the papers are restricted to aircraft gas turbines, but they are, nevertheless, of the greatest interest to all who are concerned with gas-turbine design. The aircraft gas-turbine problem is different from all other gas-turbine problems in one important respect. In all aircraft gas turbines there is the need to perform efficiently over a wide range of air density and temperature. Less fundamental, but obviously influential in design, are the weight and space restrictions in aircraft, which have so far excluded the heat exchanger and the closed cycle from aircraft application; aerodynamically and thermodynamically, however, aircraft gas-turbine practice is of the utmost interest to gas-turbine designers in general.

The paper by Owner and Hooker is a successful attempt to disentangle the interaction of the factors affecting the main thermodynamic cycle and the propulsive mechanism. They think of the gas-turbine power plant as consisting of two main components; the power generator on the one hand, and the mechanism which converts the gas horsepower delivered into thrust horsepower driving the aeroplane. This leads them to an interesting comparison on an efficiency basis of the various kinds of aircraft power plant. They consider in particular, five cases, two of which, the piston engine and the ram jet, are not gas turbines at all. It is interesting to note that to achieve modest speeds it is our habit to start with a reciprocating motion, to convert it to a rotating motion by means of which fore-and-aft motion of air is achieved. When the gas turbine appeared it became possible to go faster, using either a jet or a propeller, by starting with a rotational motion and converting it into fore-and-aft motion of the air. For the very fastest speeds of flight we need have neither reciprocating nor rotational motion; we begin and end with fore-and-aft motion using what is graphically described as the ram jet!

Owner and Hooker also define the merit of the ducted-fan type of engine within a certain restricted field, and once again in considering trends we cannot but wonder whether the almost complete ignoring of this form of gas turbine aircraft engine does it justice, though Alford states that exhaustive theoretical investigation in the U.S.A. has not exposed a case for practical development.

The paper by Owner and Hooker makes clear the claims of the propeller turbine for aircraft, and this engine has been developed to an advanced stage in Great Britain. From Alford's outline of the aircraft gas-turbine position to date in America, it is clear that the emphasis of development there has, so far, been on the jet propulsion gas turbine, and on the reciprocating engine combined with the exhaust turbine. The propeller turbine has not had anything like the same degree of development there as in Great Britain. His is the only paper which draws attention to the possibilities of the supersonic compressor. This is an axial compressor which employs an air velocity relative to the blades of a Mach number of 1·2 or more. The chief merit of a compressor of this kind would appear to be compactness, as higher temperature-rises per stage should be possible with it than with blading working at sub-sonic velocities.

(To be continued)

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I.M.M. Abstracts.—The Institution of Mining and Metallurgy has begun the publication of monthly abstracts of world literature on economic geology and mining (excluding coal), mineral dressing, extraction metallurgy (excluding iron, but including refining), and allied subjects of interest. Annual subject and author indexes will be issued. For the time being "I.M.M. Abstracts" will be published as part of the *Bulletin* of the Institution and will be issued free to members and subscribers. It is stated that the subscription rate for the *Bulletin*, including "I.M.M. Abstracts," is £3 per annum (twelve monthly issues), and inquiries should be addressed to the Institution at Salisbury House, Finsbury Circus, London, E.C.2.

Underground Car Parks.—A report entitled "Precautions Against Fire and Explosion in Underground Car Parks," has just been issued by the D.S.I.R. (published by H.M.S.O., price 1s.) as No. 28 in the series of Post-War Building Studies. The report is a technical review of the whole question and contains many recommendations. It will be of interest to those authorities concerned with the formulation of safety regulations, to architects, structural and ventilating engineers, and to makers of fire-fighting equipment. Because of the limited value of structural precautions against explosions, the recommendations in the report are mostly directed against fire spread, and standards of fire resistance are given.

American Engineering News

(From Our Own Correspondent)

Mechanised Booking of Railway Seat Reservations

Pennsylvania Station in New York City is, at present, installing a number of semi-automatic devices making it possible for a person inquiring at a ticket window to learn in twenty-six to forty-five seconds what space is available on a train for any date and to obtain the ticket immediately. According to railway officials, the introduction of the new system will save from a few minutes to a half-hour during holiday travel peak periods by eliminating back-and-forth conversation between the booking office clerk and the clerk in the diagram room, where space records are kept. The new devices, known as "Intelex," were developed by the International Standard Trading Corporation, an associate of the International Telephone and Telegraph Corporation and are an outgrowth of an electronic calculator. The Pennsylvania Railroad is the first industrial user of the system, which operates as follows.

A traveller asks at the booking office for sleeper accommodation on a certain train. The clerk dials on an automatic inquiry set to select the city of destination and the departure date. Immediately he hears a magnetic recording which informs him what space is available. As soon as the traveller books his accommodation, the clerk sends to the diagram room a short coded message by teletype, ordering the desired space and allocating a ticket number. This message goes through an electronic switching unit guiding it to the appropriate space diagram. Ranged in the diagram room there are rows of filing console cabinets in front of which sit girls with teleprinter machines beside them. Filed in the console cabinets are some 25,000 car diagrams, showing what space is available and what is reserved on all of the company's trains for the next sixty days. The electronic switching unit decides from the code message which console contains the diagram for the desired booking. It then spells out the order on the teleprinter machine beside the proper cabinet. At the same time, it pulls out the exact chart among the 2500 in that particular filing console, causing it to drop in front of the girl the instant she reads the printed message. All the diagram girl has to do is to mark the booking on the chart, which then automatically drops back into the console, and to transmit on the teleprinter a confirmation message to the booking office clerk, who hands the ticket to the purchaser. The system is already being used to handle bookings on trains from New York to Chicago and is to be in use throughout the Pennsylvania system by the end of next year.

American Productive Capacity

The Korean incident has turned public attention to the current capacity of America's industrial machine, and official plans are being prepared for its rapid mobilisation should a national emergency demand it. The five pivotal industries—steel, aluminium, aircraft, power and automotive—are substantially larger and better equipped to-day than they were in 1939. Steel productive capacity is now at the rate of 90,000,000 ingot tons per annum, 25 per cent higher than the 1939 potential. Aluminium capacity, at present, is rated at 1,400,000,000 lb a year, compared with 327,000,000 lb in 1939. To build up the aluminium industry to its greatest wartime potential, the U.S. government constructed forty-five mills, comprising two alumina plants, nine aluminium refining plants and thirty-four metal fabricating works. Weakest of these five basic industries is the aircraft industry, which turned out only 2544 military aeroplanes in 1949. However, it is said to be capable of producing 7500 military aircraft within a year if instructed to operate on a wartime basis. Electric power production reached a peak of 6,102,288,000kWh in the week ended on June 24th. This compares with a pre-war average weekly production in the vicinity of 3,400,000,000kWh. In spite of the prolonged Chrysler strike and with relatively little over-time, automotive factories in the United States built almost four million vehicles during the first half of this year; an increase of almost 100 per cent over pre-war output. In the face of a possible threat to natural rubber resources in the Far East, the National Security Resources Board has decided to restore a number of war-time synthetic rubber plants to production, and to increase output of synthetic rubber from a current 30,000 tons to 50,000 tons per month by the end of the year.

A Trailer-Carrying Aircraft

A new transport aircraft which can land and then take off a few minutes later without its cargo-laden fuselage is being flight tested by the United States Air Force. This "Fairchild XC-120 Pack Plane" is a twin-engine, twin-boom aircraft and can be likened to a trailer truck which is mobile with or without its trailer. The "XC-120's" detachable fuselage has front and rear clamshell doors which facilitate rapid loading and unloading. An alternative use for the "pod" is to equip it as a machine shop, hospital, military headquarters or communications centre. The present pack-plane has a fuselage of 2700 cubic foot capacity and can carry up to 20,000 lb of freight. Fully loaded and equipped with 3250 h.p. Pratt and Whitney engines, the entire aircraft weighs 64,000 lb and carries a crew of five. In order to facilitate the separation of the fuselage from the remainder of the craft, the plane has been equipped with quadricycle landing gears consisting of four dual-wheeled main units, two on each side. Furthermore, the fuselage has four small dual-wheeled gears which permit it to be towed away from the "mother" unit.

Unification of Bolt and Nut Standards

After unification of screw thread standards had been reached by Great Britain, Canada and the United States in 1948, further proposals for unified hexagonal bolt head and nut dimensions and wrenching clearances are nearing completion. At a Press conference held in New York on July 5th, the leader of the British delegation to the conference on bolts, screws and nuts, Sir Anthony Bowlby, Joint General Manager of Guest, Keen and Nettlefolds (Midlands), Ltd., said that in spite of the burden already accepted by British industry in the unification of screw threads which are based on a slight modification of the American standard, agreement had been reached in Great Britain that the new unified hexagon sizes should not be based on the British hexagon system, but on a selection from American standards. He pointed out that to the British, the American system appeared to have been needlessly complicated and somewhat illogical at several points, such as the difference in hexagon size of bolt head and nut for one and the same nominal screw thread size. However, as a result of the conference, the following basic proposals have been adopted: Designation as "Unified" standard of the hexagon sizes of the existing American Standard Heavy series of nuts and bolts from ¼in to 2in nominal diameter inclusive, and of the hexagon sizes of the existing American Standard Regular series of nuts and bolts in the bolt diameter range of ⅜in to 1in.

Designation as "Unified" standard of the following across-flats dimensions:—

Nominal diameter, in	Width across flats, Bolt, in	Nut, in
¼	7/16	7/16
5/16	½	½
⅜	9/16	9/16
7/16	5/8	11/16
½	¾	¾
9/16	13/16	13/16
⅝	15/16	1

It has been agreed that unification of across-flats dimensions was the most important object of the conference and that differences in practice in the other bolt head and nut elements would not affect spanners and therefore are comparatively unimportant regarding the interchangeability of British, American and Canadian bolts and nuts.

Big Sandy Dam

Construction work on the Big Sandy Dam and dyke near Eden, Wyoming, which ceased due to the outbreak of war in 1942, will be resumed as the result of a contract authorised recently. The dam and dyke are water conservation structures included among the units of the Eden project of the U.S. Bureau of Reclamation within its programme of water resource development in the seventeen Western states. The Eden Project area occupies the broad, flat portion of the valleys of the Big Sandy and Little Sandy Creeks. Construction of the dam was started in 1941 by the Civilian Conservation Corps and was 16 per cent complete at the time of cessation. Under the terms of the contract, an earth-fill dam 2300ft long and 70ft high will be erected across Big Sandy Creek, with a concrete-lined open channel spillway on the right abutment and outlet works on the left abutment. An earth-fill dyke, more than 1½ miles in length will be constructed north of the left end of the dam. The present plan of project development will provide storage regulation to serve about 20,000 acres of land, including 9000 acres currently irrigated. The existing distribution system, which has badly deteriorated, will be rehabilated, enlarged and extended to serve the greater area, and a drainage system will be constructed. Completion of Big Sandy Dam and its canal system is planned by the end of 1952, in order to supply water for the project area during the 1953 irrigation season.

Rolling Mill Equipment Cartel

A civil anti-trust suit by the U.S. Department of Justice has been filed in the Federal District Court at Pittsburg against the United Engineering and Foundry Company, of Pittsburgh, and thirteen foreign concerns, including Davy and United Engineering Company, Ltd., English Steel Corporation, Ltd., and Darlington Forge, Ltd. The complaint states that, by participating in an international cartel to divide the world market in rolling mill machinery and equipment, each of the companies concerned undertook to restrict its output to "an agreed territory." In accordance with the Sherman Anti-Trust Act, the Federal court is being asked to declare all existing contracts and arrangments illegal, to restrain the United Engineering and Foundry Company from renewing or reviving any of the alleged restraints, and to take such action regarding the company's patents "as will dissipate the effects of the alleged conspiracy."

New Aluminium Rolling Mill

An aluminium sheet and plate rolling mill, claimed to be the largest in the world, was opened by the Aluminum Company of America at Davenport, Iowa, recently. The works cover an area of 50 acres and are capable of producing 120in wide sheet products from ingots weighing up to 7000 lb. Cogging operations take place on a 144in, four-high hot mill equipped with vertical edging rolls. Initially, ingots are rolled broadside until the desired width is obtained; subsequent lengthwise rolling produces the required slab thickness. End shearing of the rolled slabs is performed on an up-and-down cut guillotine shear, which can cut thicknesses up to 6½in. Continuous rolling of sheet and strip stock is done on a five-stand, 100in wide, four-high, tandem hot strip mill, all the stands of which are individually motorised. The mill is followed by a rotary slitter and high-speed coiling equipment.

Steel Arched Hangars at Idlewild

At the New York International Airport, Idlewild, the chairman of the Port of New York Authority recently dedicated what are claimed to be the three largest steel span hangars in the world. The width of each hangar floor is 300ft, the depth 218ft and the height to the top of the three-pinned arch 82ft. Each hangar floor covers an area of 65,300 square feet, and is capable of handling, at one and the same time, four Boeing "Stratocruisers." Together with an additional area of 108,000 square feet of office and machine shop space, contained in the lean-to buildings at the ends of the hangars, this new unit will form an important aircraft maintenance facility for the world's potentially greatest air terminal.

Industrial and Labour Notes

Trade Unions and Productivity

The specialist teams from various British industries which visited the U.S.A. in the past eighteen months or so under the auspices of the Anglo-American Council on Productivity, have all included trade union representatives. Last October, however, a team consisting solely of trade union officials went to America—independently of the Anglo-American Council—to study the part which the unions take in that country in increasing productivity. The proposal for organising such a team was approved by the General Council of the Trades Union Congress.

The terms of reference, decided by the team itself, were :—to study the part played by American trade unions in achieving and maintaining the high average rate of industrial productivity operating in the U.S.A. ; and to consider if, or to what extent, similar methods and activities, or modifications of them, could be applied or introduced in British industry by British trade unions. At the end of last week, the team's report was published by the Trades Union Congress, although that organisation explains that " it is not an official report by the T.U.C."

Much of the report is taken up with an interesting description of the work, organisation and methods of the research and engineering staffs of American unions, with particular emphasis on production engineering and scientific management. There is also a commentary on American trade unionists' attitudes to the problems of increased productivity. In this part of the report it is noted that " in the opinion of the Americans, it is the willingness and ability of firms to compete with each other which have ensured the high rate of their economic expansion and their high standard of living." Another comment made in this section of the report is that the " American unions' attitude to company profits is typical of their acceptance of a capitalist economy, and, however high, profits at least in competitive industry, are not regarded as immoral or a social evil ; indeed, they give proof of solvency and assured employment." Usually, the report adds, high profits are considered a sign of efficiency and relatively high output per man-hour, and the main concern of American unions is to obtain a fair share of them. A fact which the team says it found surprising was the American unions' lack of interest in formal joint consultative machinery, " especially as many of them seem well qualified to make an effective contribution to plant efficiency through such machinery." But, the report says, the absence of joint consultative machinery does not mean that union-management relations are necessarily distant. The team gained the impression, in fact, that relations generally " are better than in many British factories."

The Trade Union Team's Recommendations

The final section of the report dealt with in the preceding note presents the recommendations put forward by the team of British trade unionists as a result of its investigations in the U.S.A. Those recommendations are prefaced by the remark that one of the difficulties of utilising American experiences is the considerable difference in the industrial and economic environments in which the two trade unions operate. A further comment in this connection is that the U.S.A. " has not experienced a post-war economic situation calling for a policy of wage-restraint on the part of trade unions."

The team has made twenty-two recommendations grouped under the following headings :—industrial efficiency, education and training, workshop organisation, technical advance, profits and prices, and exchange of information. In the first group of recommendations, it is suggested that larger unions and federations should establish production engineering departments and train production engineers for their national or district offices and thus further the widest interests of their members. It is also proposed that the Trades Union Congress might well have a competent technical staff to give help and guidance in establishing union production departments and to provide direct services to unions which are too small to engage their own staffs. On education and training, the team's view is that " in staffing trade union production departments it should not be enough to change the title of an organiser to that of production engineer. It is essential that he acquires a first-class training and should be equally as competent as the industrial consultants and technicians employed by management."

The recommendations made under the heading of " Technical Advance " are of particular interest. The first is that, in initiating or participating in the introduction of incentive schemes, unions should, where practicable, seek to increase production efficiency through a greater use of mechanical aids and the application of time and motion study in order to maximise earning opportunities. To this the team adds that " as trade unionists want the standard of living to rise continually they cannot justify opposition to the installation of new or modernised machinery or the use of re-deployment techniques." The report says, however, that " there is every justification for demanding prior consultation in order to plan the necessary labour adjustments." The final recommendation under this heading is that unions should seek to establish procedure—similar to that already existing in some sections of British industry—through normal negotiating machinery, for the payment of compensation for a limited period to workpeople made redundant by technological advance.

The Committee on Industrial Productivity

The second report of the Committee on Industrial Productivity was published last Monday (H.M. Stationery Office, Cmd. 7991). The Committee, it may be recalled, was set up at the end of 1947 under the chairmanship of Sir Henry Tizard, and from it four panels were constituted to study technology and operational research, import substitution, human factors in industry, and technical information services. The Committee's first report dealt with the preliminary work done by these panels during 1948, and the report now published surveys their activities in 1949.

The Lord President of the Council, Mr. Herbert Morrison, made a statement on Monday, in the form of a written Parliamentary reply, about the future of the Committee's work. The statement said that the Committee had recommended that it should now be discharged in view of the satisfactory stage which had been reached in arranging for more specialised and permanent bodies to deal with most of the important problems relevant to the increase of industrial productivity. Mr. Morrison went on to say that the Government did not wish to discourage any committee, which felt that it had done its job, from recommending its own dissolution, and was therefore accepting the proposal.

Mr. Morrison then stated that appropriate arrangements were being made for the work initiated by the Human Factors Panel to be carried on under the auspices of the Medical Research Council, the Department of Scientific and Industrial Research and the British Institute of Management. The Import Substitution Panel was being re-formed to deal with technical aspects of the development of natural resources, whether designed to save imports or not. Furthermore, the Advisory Council on Scientific Policy had set up a Standing Scientific Library and Technical Information Committee, which would take over in due course the co-ordination functions hitherto carried out by the Panel on Technical Information Services.

In thanking the members of the Committee and Panels for the helpful advice and suggestions which had been put forward, the Lord President commented that the importance of increasing industrial productivity had become generally accepted. The type of progress which the Government had looked for when setting up the Committee was, in fact, being achieved, which was a cause for satisfaction and encouragement.

Engineering Wages

At the end of last week the Ministry of Labour announced that a communication had been received from the Confederation of Shipbuilding and Engineering Unions concerning the rejected claim for an increase of £1 a week in the wages of adult male workers in the engineering and shipbuilding industries. The Confederation, it was stated, had asked that the Minister should take appropriate action.

The Ministry's statement added that in order that the matter might be fully explored representatives of the Engineering and Allied Employers' National Federation and of the Confederation of Shipbuilding and Engineering Unions had been invited to meet officials of the Ministry of Labour for a general discussion. Tnat joint meeting, we are informed, was arranged for this, Friday, morning.

The Association of Supervisors' Discussion Groups

The Association of Supervisors' Discussion Groups has recently made some changes in its constitution and, as a result, now provides for individual membership instead of being primarily a co-ordinating body for a number of separate discussion groups. It is felt that the principal effect of this change will be to give greater solidarity to a movement which has continued to grow steadily, and at the same time to give greater flexibility to the organisation to meet further expansion. The essential character of the discussion groups is being preserved by the establishment of local centres of the Association.

In the last few years the Association has been very useful as a forum for the discussion of problems with which foremen and supervisors are specially concerned. Arrangements are now proceeding for the seventh annual conference, which will be held at the Central Hall, Westminster, on December 2nd. All inquiries about the Association should be sent to the Hon. Secretary at Management House, 8, Hill Street, London, W.1.

Motion Study on the Shop Floor

The Institute of Industrial Supervisors has recently produced a pamphlet entitled " Motion Study on the Shop Floor," which has been prepared by Mr. Geoffrey P. Wade, of the Department of Industrial Administration, at the Birmingham Central Technical College, and chairman of the Motion Study Society of Great Britain. The pamphlet touches upon the history of motion study, outlines Gilbreth's investigations, and goes on to deal with the development of motion study in this country. " Methods and Procedure " are then treated and, finally, there is a short chapter entitled " The Foreman's Role." Here, Mr. Wade emphasises that the foreman is a key man in a successful motion study investigation. If a real improvement in productivity throughout a works is to be brought about, it is not enough, Mr. Wade says, " to rely on a few experts in the planning department," for they cannot possibly know of all the little sources of inefficiency on the shop floor with which the foreman is in a strategic position to deal.

French Engineering News

(From our French Correspondent)

Activity at the port of Dunkirk continues to increase. The 15,000-ton capacity grain elevator has now been repaired and is handling 45,000 tons of merchandise monthly. Oil production by the Dunkirk refinery, which was 100,000 litres a day a few months ago, is now 200,000 litres, and is expected to increase to 300,000 litres daily within the year. A 56-ton crane and 3600 tons of steel supplied under Marshall Aid are being used in the construction of the trans-atlantic vessel "Flandre," a ship of 36,000 h.p., and a speed of 23 knots. A tanker was launched at the shipyard last May, and it is hoped that by 1952 one vessel will be built each month. It is hoped that Marshall Aid will help to remedy the present shortage of plant and equipment, which is the main difficulty to be overcome.

* * *

The Carling thermal power station, which is at present nearing completion, will produce about 2 milliard kWh annually. It is expected that construction costs will not exceed 10 milliard francs. The plant will burn non-commercial coal residues brought from the mines by hydraulic pipe-lines. The first generating group will enter into service in a few months' time, and the second in the spring of 1951.

* * *

At the present rate of reconstruction, it has been estimated that a further eight or ten years will be required to complete the works at Le Havre. At the moment, only 14 per cent of the reconstruction has been completed. Monsieur Pierre Courant, deputy mayor of the port, has asked for the work to be speeded up in the interest of national economy.

* * *

The balance sheet of the Renault Régie for 1949 shows a net profit of 1·46 per cent, compared with 2·49 per cent the previous year. The reduction was due to difficulties in the third quarter; lower sales price, rises in salary and a general reduction of business. About half the profits, amounting to 350 million francs, was divided among personnel, the rest going to the State.

* * *

Professor Roubault, Director of Research at the Atomic Energy Commissariat, has declared that results of work at the pitch-blende mine at La Crouzille (Hte. Vienne) are very satisfactory. The main characteristic of this seam is that the pitch-blende is visible and can be sorted on the spot, whereas in the Puy-de-Dome mines, the radio-active mineral has to be washed and sorted like gold. At La Crouzille, a trial pit, 30m deep, was first sunk and examined, and it was then decided to open up a mine adjacent to it. Following the sorting, the pitch-blende is loaded on to trucks and the inert rock is removed separately. Examination for radio-activity with Geiger apparatus then takes place. Prospecting is continuing over an area of 15 to 20 hectares, to depths up to 350m.

* * *

The Minister of Industry and Commerce was present at the inauguration of new works at the departmental port of Gennevilliers last week. The total port installations will eventually cover 400 hectares, and six docks will be available. At the moment there are two docks, but only one is completely equipped. Three 3-ton electric cranes and a 50-ton bascule bridge have been installed at this dock, which will be able to accommodate eight vessels. It will eventually be possible for the port to receive mixed sea-river vessels drawing 4m to 4m 50, and of 1500 tons deadweight.

* * *

The French merchant navy had a total of 2,769,473 tons of shipping in service on May 1st, compared with only 800,000 tons at the end of the war. There is some anxiety among constructors concerning the lack of orders and unless new orders are placed rapidly full employment will not be possible for the rest of this year. Orders totalling 130,750 tons have been placed abroad and owing to French prices it is thought that this situation will probably continue.

Notes and Memoranda

Rail and Road

ALUMINIUM IN ROAD TRANSPORT.—We have received from the Aluminium Development Association a bound volume containing copies of the final and corrected versions of the papers read at the Symposium on Aluminium in Road Transport, held on February 14, 1950.

THE COMMERCIAL MOTOR SHOW.—The Society of Motor Manufacturers and Traders has announced that the Rt. Hon. A. J. Barnes, M.P., Minister of Transport, will open the 1950 Commercial Motor Show at Earls Court, London, on Friday, September 22nd. The exhibition, organised biennially by the Society, will continue until September 30th.

ROAD VEHICLE BODIES.—The Aluminium Development Association, 33, Grosvenor Street, W.1, has recently published a new application brochure, AB/5, under the title "Aluminium Alloy Sections for Road Vehicle Bodies," price 2s. 6d. The brochure lists a number of sections, together with their geometrical properties, which are suitable for road vehicle body building. Suitable aluminium alloys are recommended, design notes are illustrated by line drawings, workshop practice is discussed and the general information includes tables giving tolerances, rivet sizes and weights and material loading rates.

Air and Water

TRANSFER OF BRITISH SHIPS.—The Minister of Transport has issued a general sanction under the Ships and Aircraft (Transfer Restriction) Act, 1939, authorising the transfer or mortgage of British ships to British buyers resident in the United Kingdom. This will do away with form filling for this type of transfer, but individual application must still be made for transfer of ships to persons not residing or having their principal place of business in the United Kingdom, Channel Islands or the Isle of Man.

PROPOSED DAM ON THE ZAMBESI RIVER.—Mr. P. H. Haviland, Southern Rhodesia's Director of Irrigation, recently announced details of a proposed £30,000,000 Rhodesian power project. A 400ft high dam, retaining between 70 and 90 million acre feet of water, would be built at Kariba Gorge, on the Zambesi river below Victoria Falls. The installed capacity of the project would be about 600MW and eventually about six generating groups would give a peak output of about one million kilowatts over transmission lines of 175 miles to 250 miles. The scheme has yet to be approved.

NEW SURVEYING SHIP.—H.M.S. "Cook," a new surveying ship, was accepted for service on July 20th. Her hull was built by William Pickersgill and Sons, Ltd., of Southwick, Sunderland, and she was completed at H.M. Dockyard, Devonport, her main machinery being supplied by George Clark, Ltd., of Sunderland. H.M.S. "Cook" is a ship of 307ft extreme length, 38ft beam. Her peacetime complement is eleven officers and 147 men. She was launched on September 24, 1945, and is the fourth surveying ship to be completed since the war, the other similar ships being the "Dampier," the "Dalrymple" and the "Owen." The "Cook" is powered by two four-cylinder triple expansion steam reciprocating engines, giving a total of 5500 i.h.p. on a two shaft arrangement. Electrical power in the ship at 220V d.c. is derived from two 120kW steam turbine driven and two 150kW diesel driven generators.

Miscellanea

THE LATE MR. C. J. PARKER.—We have learned with regret of the death, on July 9th, of Mr. Charles John Parker, founder and managing director of Parker Engineering Service, Ltd., Staniforth Street, Birmingham. He was in his seventy-first year.

"ROBOT" PUMPING STATIONS.—Representing a new advance in oil pipe-line operation, four "robot" oil pumping stations have been opened in Illinois and Indiana, U.S.A., by the Shell Oil Company of New York. The pumps can be started, stopped, valves opened and shut and reports on operating conditions received by a control in New York by the use of teletype signals.

WATER PIPE-LINE.—Until recently the water supply for the Shell and Creole Petroleum Company's refineries on the arid Paraguana peninsula of northern Venezuela has been provided by tanker transport or distillation. This service has now been superseded by a pipe-line 80 miles in length, having a diameter at its source of 34in, with branches 24in and 20in in diameter, which conveys water to the site from a natural supply.

DR. R. G. JAKEMAN'S RETIREMENT.—Dr. R. G. Jakeman, D.Sc. (Eng.), chief designer in the Engineering Department of the General Electric Company, Ltd., at Witton, is retiring on July 31st. He joined the design department at Witton forty-three years ago and was appointed chief designer in 1933. In this position he has been responsible for the electrical design of a.c. and d.c. machines of all types, and at one time was particularly concerned with the development of rotary and motor converters. Dr. Jakeman is a member of both the Institution of Electrical Engineers and the American Institute of Electrical Engineers.

THE DES VOEUX MEMORIAL LECTURES.—The National Smoke Abatement Society has announced that it is inaugurating an annual "Des Voeux Memorial Lecture" to commemorate its first President, the late Dr. H. A. Des Voeux, who, in 1899, helped to found one of its parent bodies, and who worked untiringly for a cleaner atmosphere until his death in 1943. The intention of these special lectures will be to survey smoke prevention in perspective against a background of history, science, medicine, culture, the arts, and social reform. The first lecture is to be given at the Society's conference at Margate in September, and will be delivered by Dr. D. T. A. Townend, Director-General of the British Coal Utilisation Research Association, whose subject will be "Towards the Better Use of Coal."

A NEW ALUMINIUM DEGREASER.—Jenolite, Ltd., of 43, Piazza Chambers, Covent Garden, London, W.C.2, will shortly be marketing a new aluminium degreaser and cleaner, specially prepared to clean and degrease aircraft wings and bodies, both inside and outside, as well as fuselages and cowlings. This new chemical, it is claimed, will in no way attack the aluminium surface. The new degreaser is delivered in powder form, and must be diluted before being applied cold by ordinary distemper brush, or articles may be dipped into a bath containing the solution warmed to a temperature not exceeding 50 deg. Cent. The degreaser is non-inflammable, non-caustic and non-injurious to rubber. It has a good wetting quality, and has been proved efficient in cleaning the surface of greasy and dirty aluminium in a very short time.

BRITISH WELDING RESEARCH ASSOCIATION.—The fifth annual general meeting of the British Welding Research Association was held at Abington, near Cambridge, on July 13th, when the report of the Council and the statement of accounts for the year to March 31, 1950, were adopted. Dr. J. H. Paterson, introducing the report, expressed the Council's satisfaction with the progress of researches, saying that the new work undertaken by the Research Board during the year had already proved its value. The report notes that a pulsating pressure testing plant, for fatigue testing pressure vessels, has been installed and a large tensile testing machine has been placed on order. These large and expensive equipments, however, require considerable laboratory space, and the Council is, therefore, planning to build a fatigue testing laboratory at Abington, thus releasing a portion of the old laboratories for much needed expansion of other work.

Launches and Trial Trips

H.M. WRANGELL, motor tanker; built by Furness Shipbuilding Company, Ltd., for H.M. Wrangell, Oslo; length 560ft, breadth 80ft, depth 42ft 3in, deadweight 24,600 tons; North-Eastern Marine-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 116 r.p.m. Trial, June 26th.

SUEVIC, refrigerated cargo liner; built by Harland and Wolff, Ltd., for Shaw Savill and Albion Company, Ltd.; length 530ft, breadth 72ft, depth 43ft 4½in, gross tonnage 13,900; two sets of triple-expansion, single-reduction geared turbines taking high-pressure superheated steam from two Foster Wheeler boilers, 14,000 s.h.p. Trial, July 5th.

HERO, cargo liner; built by Hall, Russell and Co., Ltd., for Bruusgaard Kiosteruds Skipsakjeselskap, Drammen; length 263ft, breadth 41ft 10in, depth 18ft 7in, deadweight 2450 tons; Hall, Russell-Fredrikstad steam motor taking superheated steam from two boilers. Trial, July 7th.

BRITISH EXPLORER, motor tanker; built by Harland and Wolff, Ltd., for the British Tanker Company, Ltd.; length 463ft, breadth 61ft 6in, depth 34ft, deadweight 12,300 tons; Harland-Burmeister and Wain oil engine, six cylinders, 740mm stroke by 1500mm stroke. Trial, July 7th.

British Patent Specifications

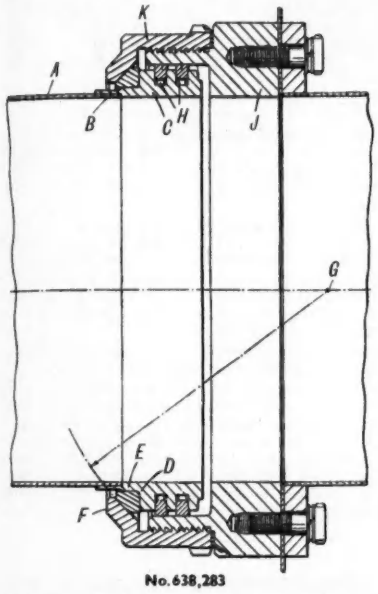
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

GAS TURBINES

638,283. February 10, 1947.—Improvements Relating to Gas Sealing Joints, Rolls-Royce, Ltd., of Nightingale Road, Derby, and (inventor) Arthur Holmes Fletcher.

This invention relates to gas-sealing joints such as are used for effecting sealings of gas-ducts to a pressure-vessel, or for effecting joints between duct-sections, and its object is to provide a sealing joint which will permit a limited relative angular movement between the parts to be sealed, but prevent relative axial movement. The accompanying drawing is a diametral section through a duct and its gas sealing joint with a wall of a vessel; and modifications are also illustrated. The duct *A* has a circular cross-section and is fabricated from sheet metal, or is a drawn section. It has welded to



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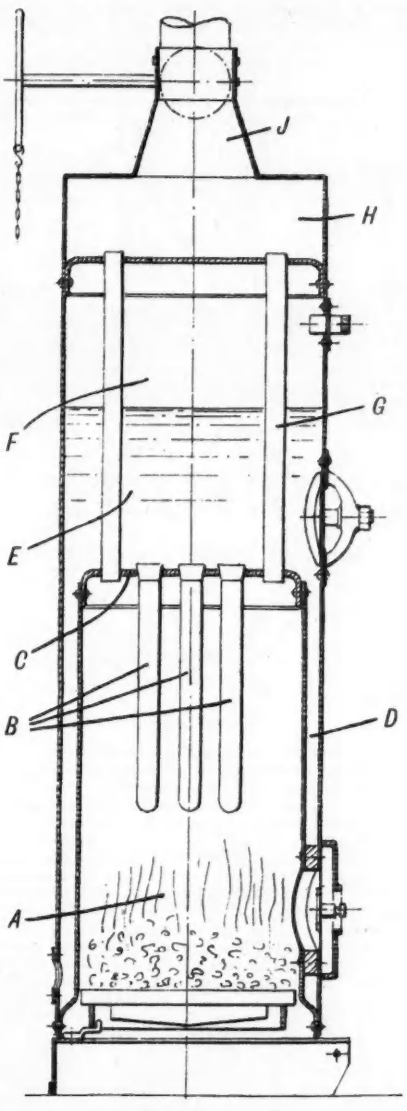
it at its end *B* a ring-like machined extension piece *C*. The machined extension has a radially extending shoulder *D* lying adjacent to the duct, which provides an abutment for a circular sealing ring *E* supported by the extension, and having a part-spherical surface *F* generated about a centre *G* which lies on the duct axis and beyond the end of the duct. The cylindrical machined extension *C* carried by the duct is also formed beyond the shoulder *D* with one or more grooves adapted to receive piston rings *H*. The wall into which the duct is to be fitted has secured to it a fitting *J* having an axial flange with an internal cylindrical surface, with which the piston rings co-operate. The fitting is also externally screw threaded to receive a ring-nut *K*, which has an inwardly directed flange formed with part-spherical thrust surface to co-act with the part-spherical thrust surface *F* on the sealing ring *E*. The surfaces are pressed into contact by the pressure within the duct and separation of the duct and the casing is prevented by the axial loads thus generated. It will be appreciated that owing to the disposition of the centre of generation of the part-spherical surfaces beyond the end of the duct, the surfaces are inclined at an angle, say 45 deg., to the axis of the duct, and axial loading applied by internal pressure within the duct forces the faces into engagement to provide an effective gas seal.—*June 7, 1950.*

STEAM GENERATORS

638,615. April 23, 1948.—Improved Vertical Boiler, Lucienne Denise Marie de Poorter, of 14, rue Liancourt, Cauffry (Oise), France.

The invention has for its object the provision of an improved vertical boiler by increasing the heating effect of the water circulating tubes, and extending the path of the gases of combustion and smoke, and therefore increasing the period of contact of the gases and smoke with the heat transmitting surfaces which decrease the temperature at which the smoke is exhausted to about 220 deg to 250 deg. Cent. In the drawing, *A* designates the firebox of the boiler, *B* the water circulating tubes that depend into the firebox and are supported by the upper end or crown *C* of the firebox, *D* an annular lower water space surrounding the firebox, and *E* the upper water space the upper part of which forms the steam space *F*. The central flue, which in



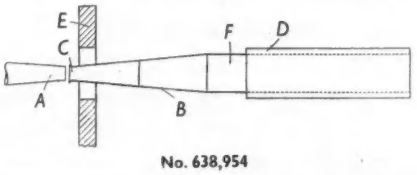
No. 638,615

the usual boilers passes through the water space and the steam space, is eliminated and replaced by smoke tubes *G* which are arranged in a circle near the periphery and place the firebox in communication with a smoke-collecting space *H* which is located above the steam space and is provided with an exhaust chimney *J*. Modifications are also shown.—*June 14, 1950.*

AERONAUTICAL ENGINEERING

638,954. March 19, 1948.—Noise-Suppressing Apparatus for Use in Conjunction with Stationary Jet Propulsion Engines, Douglas Jack Wayth Cullum, of Flower's Mews, London, N.19.

This invention is an improvement in noise-suppressing apparatus for the testing of jet propulsion engines, and has for its objects to provide optimum operating conditions for the engine while suppressing the noise, and to absorb the sound of the issuing jet to a greater degree than is attained by known detuners. A further object is to provide adjustment whereby the optimum or utmost degree of sound absorption may be achieved by the apparatus while it is at work. In the accompanying drawing *A* is the exhaust mouth of the jet engine, *B* is the suppressor tube in the form of a truncated cone in longitudinal section with an outwardly flared small end forming a throat *C* after the manner of a venturi and a large end which extends into a cylindrical detuner tube *D* of the usual type, the relative dimensions being substantially as indicated in the diagram. The diameter of the throat *C* is substantially the same as the diameter of the mouth *A*. The venturi throat is introduced towards the jet exhaust mouth through an aperture in the wall *E* of the building in which the engine, of which the jet exhaust is a part, is housed. In order to vary the pressure of the air in the region surrounding the gap between engine jet and suppressor tube, and to assist in providing optimum operating conditions for the engine means may be interposed in the suppressor body for resisting and baffling the flow



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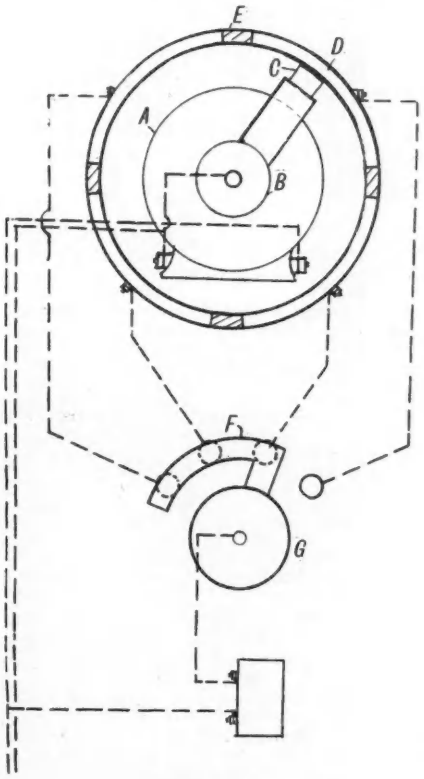
of gases, preferably at the junction *F* of the conical part with its cylindrical continuation *D* as shown. This may take the form of a hit-and-miss valve with a plurality of adjustable orifices, or a series of grids or baffles or bends in the duct, or any equivalent device, with or without an external operating element for adjusting the degree of baffling. The cylindrical continuation of the conical body part may be a lagged perforated tube and the conical body part *B* may be jacketed with a cooling medium to dissipate to some extent the heat of the jet flame. In addition, injected water or other cooling medium may be used.—*June 21, 1950.*

ELECTRICAL ENGINEERING

639,309. May 19, 1948.—Electric Current Regulator, Sidney Philip Clementson, of 7, Rhodrons Avenue, Hook, Surrey.

This invention consists in an electrical switch or regulator for controlling the average amount of current flowing in a circuit, the regulation being achieved using a mechanical method of switching the current on and off rapidly, the number of equal periods in a given time in which the current is off



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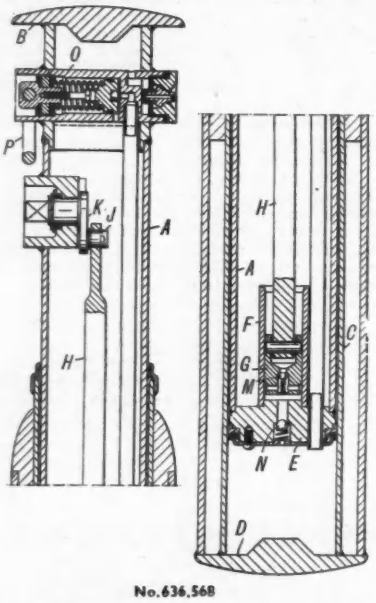
being varied in relation to the number of periods that the current is on. The drawing shows diagrammatically one convenient form of an electric current regulator embodying the invention. A salient pole synchronous motor *A* with a shaft *B* running at a speed of 1500 r.p.m. has mounted on the shaft a brush *C* arranged to revolve on the inside of a metallic ring which is divided into four segments *D* separated by insulating means *E*. The motor and the rotating brush are connected in parallel with an electric supply of 50 c/s; thus one revolution will occur during the period of 2 cycles and the brush will move across

each segment in the time corresponding to half a cycle. The brush can therefore be arranged in relation to the ring so that it always reaches and leaves each segment at the neutral point of the cycle. A selecting switch *F* has four studs connected to the four segments, and a control knob *G* when turned moves a contact across the studs, thus bringing into the circuit one, two, three or four segments. When, for example, the contact joins three studs it means that the current will be switched on for three half cycles out of every four.—*June* 28, 1950.

MINING MACHINERY

636,568. January 12, 1948.—Improvements in Pit Props and Other Telescopic Struts, George Herbert Dowty, of Arle Court, Cheltenham, Gloucester.

This invention concerns hydraulically actuated telescopic struts intended more particularly for use as pit props in shoring up ceiling sections in mines. A pit prop described has a relief valve for relieving pressure below the ram, positioned adjacent to the upper end of the ram and communicating with cylinder space through a conduit extending down from the valve and through the bottom end of the ram, and has a control member associated with the valve extending to the outside of the ram, whereby the valve can be opened or freed to open by an



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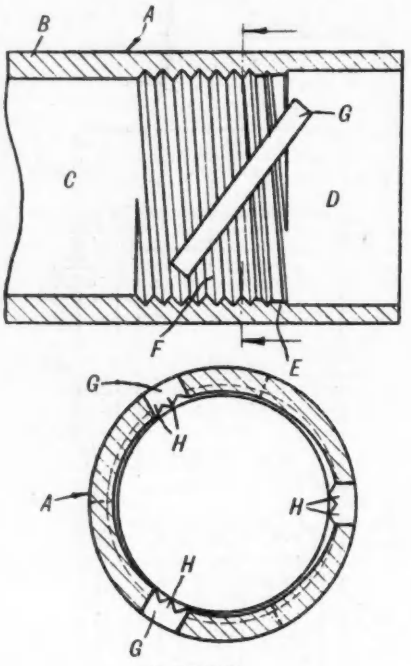
outward pull exerted on the member. As shown in the drawing, the prop comprises a hollow tubular ram *A*, which is closed at its upper end *B* and is slidable at its lower end telescopically within an outer cylinder *C* closed by a foot piece *D*. On the lower end of the hollow ram is mounted a closure disc *E* having a gland engaging the inner surface of the cylinder. The disc is rigid with a coaxial tube *F*, which extends for a short distance upwards into the ram to form the cylinder for the piston *G* of a reciprocating pump. The piston has a connecting-rod *H* extending upwards through the ram to where it is pivotally connected to the pin *J* of a crank *K* which can be oscillated between stops from the outside of the ram by a detachable handle engaging the square section end of the crankshaft. The piston *G* and the closure disc *E* have appropriate non-return valves *M* and *N* respectively, whereby reciprocation of the piston causes actuating fluid to be transferred from the interior of the ram through the valves into the cylinder space below the ram. Just below the upper end of the ram there extends transversely across the ram a generally tubular housing *O* for a relief valve, and a control link *P* is associated with the relief valve in such manner that an outward pull on the control member will unseat the valve or free it to allow it to unseat so that contraction of the prop or strut can be effected when desired.—*May* 3, 1950.

TUBE AND PIPE COUPLINGS

639,243. March 19, 1948.—Improvements in or relating to Pipe Couplings, Sidney Herbert Jones, of 12 and 14, Church Street, Folkestone, Kent.

This invention relates to coupling devices for pipes or tubes. The object is to provide a threaded socket type of joint in which no preliminary threading has to be done on the ends of pipes or tubes of non-ferrous materials, such as copper and aluminium which it is required to join. Referring to the drawings, the socket member *A* consists of a barrel *B* having a circular bore. The bore is in two portions, the inner or main portion *C* being of a diameter less than that of the pipe to be coupled and the outer portion *D* being of a diameter to receive the pipe to be coupled. Between the two portions *C* and *D* is a portion *E*, which is tapered outwards at the entry end. The socket member is internally screw threaded at *F* and the thread extends through the tapered portion *E* into the main portion *C*. Three slots *G* are cut through the



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wall of the socket member *A* at an angle, for example, of 120 deg. to each other. Each slot is at an angle with the longitudinal axis of the bore, and extends from a point in the outer portion of the bore through the tapered portion to a point in the threaded part of the main portion. The thread extends beyond the inner ends of the slots. The slots thus form gaps in the thread of the socket member. The faces *H* of the threads formed by the gaps constitute cutting edges to cut a screw thread in the end of a pipe as it is fed into and rotated in the socket member. Since the screw thread is continuous, the external thread on the pipe will match the internal thread on the socket member. The slots may be replaced by circular holes in the wall of the socket member or by grooves which extend longitudinally in the bore from the open end into the threaded portion of the socket member.—*June* 21, 1950.

Personal and Business

The English Electric Company, Ltd., announces that Mr. Peter Scott has been appointed publicity manager.

Mr. Arthur H. Johnson has resigned his position as chairman and director of Musgrave and Co., Ltd., Belfast.

Mr. Trevor Jenkins has been appointed chief engineer of Guest Keen Baldwins Iron and Steel Company, Ltd.

Mr. F. R. Moberly, secretary of Richardsons Westgarth and Co., Ltd., has been elected to the board of directors.

London Transport announces the appointment of Mr. G. J. Dickins as principal development assistant to the development officer.

Mr. D. G. Denoon, joint publicity manager of British Insulated Callender's Cables, Ltd., has been elected chairman of the BEAMA publicity committee.

The Union Castle Line announces that Captain T. W. McAllen, who joined the Union Castle Line in 1915, will become Commodore on August 12th, in succession to Captain J. C. Brown.

Lieut.-Col. J. P. Hunt, managing director of Hallamshire Steel and File Company, Ltd., has been elected chairman of the National Association of Rolled and Re-Rolled Steel Products.

Beier Infinitely Variable Gear Company, Ltd., 19, Ebury Street, London, S.W.1, has been formed for developing the Beier infinitely variable gear. Mr. Arthur Ryner is the managing director of the company.

The Lumley-Saville Organisation states that it has moved its headquarters to Birmingham Road, Stratford-on-Avon (telephone, Stratford-on-Avon 3681; telegrams, "Saviltrac, Stratford-on-Avon.")

The Council of British Manufacturers of Petroleum Equipment states that it has regretfully accepted the resignation of its director, Col. A. S. Osborne, who is taking up an appointment in industry.

A. Reyrolle and Co., Ltd., has announced the retirement of Mr. E. E. Grover, areas manager (mining). He has been in the service of the company for thirty years. Mr. H. Taylor has been appointed to succeed Mr. Grover.

Ruston and Hornsby, Ltd., announces the following appointments:—Mr. L. Ingall, home sales manager, in succession to Mr. C. R. Dawson, who has left the company's service; Mr. T. B. Colman, works manager at Grantham, in succession to Mr. T. H. Edwards who has retired.

F. J. Edwards, Ltd., 359-361, Euston Road, London, N.W.1, announces the appointment to the board of the following executives:—Mr. R. A. Johnson Jun., director; Mr. G. M. Hayward, technical director; Mr. S. Plastock, machine tool director; and Mr. C. Dalley, works director.

B.S.A. Tools, Ltd., announces the opening on August 1st of its new London office at 93, Albert Embankment, S.E.11 (telephone, Reliance 2891 for machine tools, and Reliance 3891 for small tools). The Leeds office of the group is now at 9, Mill Hill, Boar Lane, Leeds (telephone, Leeds 22542).

Rotoplunge Pump Company, Ltd., has been acquired by Monitor Engineering and Oil Appliances Ltd., a company in the Parkinson and Cowan group. As from August 1st, the address of the Rotoplunge Pump Company, Ltd., will be Flaxley Road, Stechford, Birmingham, 9 (telephone, Stechford 2253).

The South Western Electricity Board has appointed Mr. R. H. Upton, M.Eng., M.I.E.E., A.M.I.Mech.E., as district manager, East Devon, in the Devon sub-area, in succession to Mr. H. F. G. Woods, B.Sc., M.I.E.E., M.I.Mech.E., who is retiring after nearly forty-five years in the electricity supply industry.

Jack Olding and Co., Ltd., announces that it is terminating its long association with the Caterpillar Tractor Company. It will continue to supply spare parts and service tractors until such time as the Caterpillar Tractor Company has made alternative arrangements. At the same time Jack Olding and Co., Ltd., states that it has been appointed sole world distributor for the track type tractors and ancillary equipment of which the production is being undertaken by Vickers-Armstrongs, Ltd.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

British Association

Wed., Aug. 30th, to Wed., Sept. 6th.—Annual meeting in Birmingham.

Institution of Metallurgists

Today to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 9.30 a.m. to 6.30 p.m.; Sundays, 2.30 p.m. to 6.30 p.m.

Institution of Mining and Metallurgy

Tues., Sept. 19th, to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Scientific Instrument Manufacturers' Association

Tues., Sept. 5th, to Fri., Sept. 8th.—Exhibition and Symposium at the Examination Hall, Queen Square London, W.C.1.

Institute of Metals.—The forty-second annual autumn meeting of the Institute of Metals is to be held in Bournemouth from Monday to Friday, September 18th to 22nd. The programme provides for three technical sessions—on Tuesday, Wednesday and Thursday mornings—for the discussion of papers, in addition to works visits and other social events. The Autumn Lecture will be delivered on Monday evening, September 18th, by Mr. E. E. Schumacher, chief metallurgist of the Bell Telephone Laboratories, Inc., on the subject of "Communications Metallurgy." The headquarters of the Institute for the meeting will be at the Pavilion, Westover Road, Bournemouth.